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MATHO:

OR, THE

Cosmotheoria Puerilis:

In Ten Dialogues.

WHEREIN,

From the PHÆNOMENA of the MATERIAL WORLD briefly explained, the PRINCIPLES of NATURAL RELIGION are deduced and demonstrated.

The whole accommodated to the CAPACITIES, and intended for the INFORMATION of YOUNG STUDENTS.

By the late learned and ingenious AUTHOR of the *Essay on the Human Soul.*

By Andrew VOL. I. Baxter

The THIRD EDITION; corrected and enlarged.

Nam corpus hoc animi pondus & pœna est: premente illo urgetur, in vinculis est; nisi accessit philosophia, et illum respirare rerum naturæ spectaculo jussit.——Vetat me cœlo interesse; id est, jubet me vivere capite demisso. Seneca.

LONDON,
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MDCCLXV.

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1899.

TO

Maſter *GLOVER*,

Son to PHILIPS GLOVER

OF

Wiſpington, Eſq; *in Lincolnſhire*.

SIR,

I Here preſent you with a * *tranſlation*, the *original* of which was wrote for a young gentleman much

* What the author here calls a *tranſlation* contains ſix or ſeven times more matter than the *original*, which was only a pamphlet of eight or nine ſheets.

about your age. The progreſs you and he ſhall make in theſe things, will beſt ſhew me how I have executed the deſign. It is reaſonably ſuppoſed by good judges, that youth is better qualified to learn, than we are aware of; or really than men are to teach. True knowledge has, indeed, been wrapt up in ſuch a myſterious dreſs, as if it were deſigned to diſcourage young perſons from attempting it. How I came to make a trial what a contrary method might do, would require more words to ſhew, and apologize for, than is proper to give you the trouble of hearing.

If I have rightly proſecuted the plan I propoſed, what is firſt brought in view will ſuit your humour at preſent, and what follows will ſerve to amuſe

amuſe you when farther advanced. But if upon experience, the whole ſhould be found of little uſe, as it may be thrown aſide, it can do no harm.

You ought to know, Sir, that it depends in a great meaſure on thoſe of your age and fortune, ſo to lay out your early years, as to make the riſing generation virtuous, by the authority of your examples afterward. Your amuſements therefore are of more conſequence to the world than what is commonly imagined. This, beſides your own private advantage, is the moſt noble *end* you could poſſibly aim at; and will, I am perſuaded, fire you with a reſolution of being among the foremoſt in the purſuit of knowledge, and practice of

virtue, which are naturally allied to each other.

I am with great zeal,

Sir,

Your moſt faithful,

Humble ſervant.

TO THE

READER.

THE firſt great objection againſt the following performance will be, that Matho is made to ſpeak above his years: but in this caſe we ſhould, I think, moderate the rigour of criticiſm a little. The deſign of writing for the uſe of young perſons can only be, that they may underſtand what is ſaid, though they ſhould not be able at firſt to ſay the things themſelves: if they could ſay the ſame things, there would be no occaſion of writing for their uſe. In the books, which are firſt put into our hands when we go to ſchool, children are made to talk Latin *prettily; not that children can talk ſo, but that by reading thoſe things they may learn to talk ſo: and perhaps before a young gentleman can talk as fine* Latin, *as Children are ſuppoſed to do there, he may be brought to think as juſtly as Matho is ſuppoſed to do here. After all, there is no common ſtandard in this caſe; the ſame difference may be obſerved between young perſons of thirteen or fourteen, as between men of thirty or forty. If I have beeen ſo fortunate as to make it appear natural, that a young gentleman might enter eaſily into the ſubjects diſcourſed upon, by repreſenting them in a familiar way,*

that will be the beſt apology: but every reader will be a better judge of this than I am; and a young reader a better judge than one who knows the things already, by the learned methods of treating them.

There will, no doubt, be other objections, which I dare not pretend to anſwer; but muſt refer myſelf to the indulgence of the judicious and candid reader, who will beſt ſee the difficulty of ſuch an undertaking. A firſt attempt *of this nature muſt be many ways imperfect: yet, I think, the method may be of ſuch advantage, that it is worth while to make a trial, and even that at the hazard of miſcarrying.*

ADVERTISEMENT.

THESE Philoſophical Dialogues *have been univerſally well received, and found to anſwer the purpoſe which their learned and pious author* * *had in view; the advancement and defence of true religion; in oppoſition to the ſceptical refinements of ſome late writers: and this, by fixing its principles and obligations on an invariable and ſure foundation, the divine attributes, as clearly diſplayed in the works of nature.*

A miſtake, however, in the aſtronomical theory, which the author did not live to rectify (as he intended) had diſguſted ſome readers; and might have created a prejudice againſt thoſe parts of the work which, for the execution

* *Mr. William Baxter, author of the Enquiry into the Human Soul.*

should be Andrew.

as well as the deſign, were altogether unexceptionable.

To remove this ſtumbling block, the conference, which was chiefly affected by that miſtake, is entirely ſuppreſſed, and another added to fill up the vacancy. In this, the occaſion of the error is pointed out, and obviated;—the doctrine of centripetal forces is carried farther;—and their quantities *and* effects *exemplified in ſome of the more remarkable inſtances:—the whole in as near a conformity to the author's plan as could be contrived; and requiring little more than a competent knowledge of common arithmetic.*

The preſent ſtate of aſtronomy ſuggeſted another addition ſtill.—The notion of the mundane ſyſtem, which youth get from their tutors, is oftenеſt imperfect and ſuperficial; while the phyſical aſtronomy, cultivated by the great maſters, is too ſublime for common uſe; and, with every new improvement, grows more and more intricate and forbidding.

But

But an aſtronomy more generally uſeful, and of eaſy application, is, what we may call, the popular, *or* arithmetical; *accommodated to the ſervice of the huſbandman, the ſeaman, and the clergyman; and particularly of the hiſtorian and chronologer. This was probably the primitive aſtronomy of Babylon, Egypt, and China, though now neglected and almoſt forgot; nor indeed have the grounds of it ever been properly explained.*

And yet ſome late publications have ſhewn the neceſſity of reſtoring it, in its ancient genuine form of temporary cycles *and* periods: *and theſe not founded in fanciful criticiſm, but deduced from actual obſervations, in a legitimate demonſtrative way.*

Be this ſaid without offence to the Moſaic aſtronomers, whoſe candor and ingenuity are not impeached or ſuſpected. What might miſlead them, was the conſiſtency of a cycle with itſelf, which they ſeem to take for a proof

of

of its being the true cycle. *In this they were greatly deceived; for ſuch conſiſtency proves only the truth of arithmetical rules, but can ſignify nothing towards determining the quantities of the revolutions on which the cycle is to be conſtructed: theſe muſt be had from obſervation only. Another, but leſs excuſable, error of thoſe gentlemen, is their obſtinacy in maintaining the commenſurability and perfect equability of the heavenly motions; this, we ſay, can hardly admit of an excuſe; becauſe it contradicts univerſal experience, and the teſtimony of their own ſenſes, if they would take the trouble to uſe them.*

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rious

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ERRATA.

Page 13. line 2. for or, read on; p. 62. l. 6. for turned, r. turnep. p. 111. l. 29. r. upper. p. 112. l. 2. for it, r. it is. p. 124. l. 4. from bottom, r. viciſſitudes. p. 127. in the note, for *ſum*, r. *cum*.

MATHO:

MATHO:

OR, THE

Coſmotheoria Puerilis,

A DIALOGUE, &c.

The firſt Meeting.

Matho, a boy of a fine genius, deſires his friend Philon to explain, and, if poſſible, bring within the reach of a boy's capacity ſome things in philoſophy, concerning the heavens and the earth; ſuch, to wit, as were moſt neceſſary to be known, and likewiſe pleaſant: that thoſe of his age might the ſooner accuſtom themſelves to the contemplation of truth, and the ſtudy of nature, inſtead of paſſing the firſt ſtage of their lives in the ſtudy of words only: whereupon they enter on the conſideration of the ſpherical figure of the earth, and the nature of gravity.

MATHO, PHILON.

M. I AM glad, Philon, I have met with you.

P. Upon what account, Matho?

M. There are ſome things I am very deſirous of knowing, nor have I confidence to addreſs myſelf to any other perſon than you, of whoſe friendſhip I have had ſo many proofs.

P. If I can aſſiſt you in any thing, you may be aſſured of my inclinations.

M. But perhaps I may be troubleſome to you with my childiſh fancies.

P. You cannot be troubleſome to one who is glad to ſerve you; and beſides, the matter ſeems to be of conſequence.

M. To me it is, if that were enough to make you think it deſerved your attention.

P. It ſhall be enough, I aſſure you, to make me think it worth my moſt ſerious attention.

M. Tell me therefore, Philon, in the firſt place, could you bring down ſome part of your knowledge to my capacity?

P. I cannot tell that; but this I can aſſure you, that I will do my beſt to make you underſtand, in ſome meaſure, any thing I know myſelf. But you ſeem to have conceived much too high an opinion of my knowledge.

II. *M.* My father, and ſeveral of our friends, frequently tell me I am troubleſome with my idle queſtions: wherefore they either ſend me away with a joke, or bid me mind my grammar and parts of ſpeech for ſome time, and not meddle with philoſophical matters, till I am ſix or ſeven years older; for that theſe ſubjects cannot be underſtood till one has attained to ſeventeen or eighteen years of age. Now I ſhould be glad to know, if there may not be a method of teaching boys what they are fond of learning; or if any one can have a curioſity to know what he has not yet a capacity to underſtand?

P. Certainly, Matho, an earneſt deſire of knowing any thing promiſes a readineſs of conception; becauſe an uneaſineſs under ignorance quickens

quickens the apprehenſion, and makes the mind attentive to catch any hint: but notwithſtanding this, you muſt begin with the firſt principles of things, and ſuch as are neceſſary to lay a right foundation; for moſt people are deſirous to be taught, but cannot beſtow the neceſſary application.

M. You even increaſe the earneſtneſs of my deſire, ſince I find you are of the ſame opinion with myſelf. However, though perhaps I may not yet be capable of comprehending the reaſons of many things, I would nevertheleſs know the things themſelves as they are: there being a great difference, as I think, between having one's head ſtuffed with the ſilly notions of the vulgar, and having firſt been told the truth of the caſe, as it really ſtands.

P. Nor is it indeed matter of indifference, Matho, whether *truth* or *error* firſt takes root in the minds of men. Wherefore the plain and ſimple truth is to be laid open to young perſons, as ſoon as they begin to turn their thoughts on any ſubject; and the point is to be illuſtrated, when it can be done, with ſuch familiar compariſons, as ſuit their age, or have fallen under their obſervation. For unleſs the mind is thus early tinctured with truth, they naturally fall into abſurd notions concerning whatever they obſerve; and contract ſuch prejudices as they are ſcarce ever able to get the better of.

M. You will therefore give me your aſſiſtance in this affair, on a double account; both to help me to avoid this inconvenience, and alſo to relieve me from a preſent uneaſineſs: wherefore leaving farther preambles, I ſhall freely tell you the things which frequently

occur to my mind, and often perplex my thoughts.

III. I ſee the heavens over my head, and tread on the earth with my feet; but I am at a loſs what to think of that *mighty concave* above me, or even of this very earth I walk upon. I often think whether the earth may not ſtretch out in breadth to immenſity, ſo that if one was to travel it over, one ſhould never be able to get to the *end* of the earth, but always find room to continue the journey: nor can I ſatisfy myſelf as to the depth of the earth, whether it hath any bottom: and if ſo, what it is that can be below the earth. As to the heaven, I need ſay nothing: every change that happens, and every object ſeen there, perplexes me with doubts and fruitleſs gueſſes. I often wonder how the ſun moves over ſo large a ſpace every day, and yet ſeems not to ſtir out of its place. I would know where he goes beyond the mountains in the evening; what becomes of him in the night time; whether he makes his way through the thickneſs of the earth, or the depth of the ſea, and ſo always ſhews himſelf again from the eaſt the next morning. It ſeems ſtrange, that being ſo ſmall a body as he is, he ſhould be ſeen every where, and ſtill of the ſame bigneſs. The various nature of the moon ſeems yet more perplexing: to-night perhaps you can ſcarce diſcern her; but in a few days ſhe becomes larger than the body of the ſun itſelf: in a little time after ſhe decays, and at laſt wears quite away; yet ſhe recovers again. In a word, ſhe is never the ſame, and yet ſtill becoming what ſhe was before. What means that multitude of ſtars ſcattered over the face of the whole ſky, whoſe

whose number is so great that it is become proverbial!— There are other things, Philon, I want to be informed of; but these are the main difficulties, which exercise my thoughts, and perplex my mind with endless doubting. We are bid to be silent with our doubts concerning these matters, which chiefly strike a boy's mind with admiration, and raise his curiosity: we are bid to be content with our ignorance for not a few years, till we become as it were habituated to a want of knowledge; till the uneasy sense arising from curiosity, and unsatisfied desire, has lost its edge.

IV. *P.* You have reckoned up a good many particulars, Matho, of which some are more difficult to be known than others: of some of them even men themselves are yet ignorant, so that those of your age cannot be supposed to know them. However, I am not without hopes but that you may receive some sort of satisfaction as to the greatest part of your doubts. But what boy of a thousand is it, to whom his ignorance in these points gives the least trouble?

M. Forgive me, Philon, you have perhaps been so earnest in your pursuits, since you became a man, that you have forgot what past in your mind when you were a boy. We are sometimes cloyed even with our own diversions, and seek relief from something else: we walk then by two's or three's, or lie down perhaps upon the grass. At those times the heavens offer themselves to our eyes and minds, when thus unoccupied with any thing else; our ignorance creates our wonder, and we are under no restraint in discovering our thoughts to each other. Every thing is a difficulty to us, and we endeavour to

ſolve our doubts by conjectures, which are certainly ridiculous enough, if you men were to over-hear them.

P. And yet I obſerved you ſaid ſomething juſt now, while you were telling me your difficulties, which looked like obſervation and experience.

M. Pray what was it?

P. How do you know *that the ſun, being,* as you ſay, *ſo ſmall a body, does appear every where of the ſame bigneſs?*

M. Why, we compare our reaſons together, and ſometimes help one another out. One obſerves that a houſe, if it were at ſeven or eight miles diſtance, could ſcarce be ſeen, or at moſt appear but very ſmall: ſome of us have been at thirty or forty miles diſtance in the country; we find the ſun appeared juſt as big there as here: and yet the ſun ſeems by no means ſo large as a houſe. This ſeems ſtrange to us; for, on enquiring, we have the ſame account from all our comrades.

P. Very good, Matho, I hope your doubts may be ſo much the more eaſily ſatisfied, as you are thus ſolicitous to have them removed. It is a happineſs where the deſire of knowledge becomes a ſort of diſeaſe; for then we greedily liſten to the reaſons of things, as affording us a proper remedy for this uneaſineſs of the mind.

V. As to the earth, that we may begin from thence, it is neither ſtretched out into an immenſe breadth, as you imagined, nor is it deep without limits, but bounded on all ſides; and is nearly of a ſpherical figure.

M. You

M. You mean it hath a round figure like that of a globe, or that perhaps the earth itſelf is a huge globe.

P. That is my meaning.

M. How, I pray, is that known? For this round figure of the earth would remove my difficulties, as to its infinite breadth, or bottomleſs depth; but it raiſes other doubts no leſs perplexing to one's mind.

P. What are they?

M. How can the earth, if thus bounded, and detached from every thing elſe, reſt without ſomething to ſupport and keep it up? Why doth it not fall downward? By what force do the *under-parts* of it ſtick cloſe to the *upper?* ——

P. Suſpend a little, if you pleaſe, your enquiry into the reaſons of things, or *why they are* ſo, till you are once certain of the facts, or *that they are really ſo.* Wherefore tell me, Matho, have you never heard that the globe of the earth hath been ſailed round?

M. I have indeed heard this in diſcourſe, but did not underſtand the meaning of that *ſailing round:* I imagined it might be as when a man is ſaid to *ride round* a country, or *walk round* a field.

P. Well, but if a ſhip ſhould ſet ſail from a port, ſteering weſtward, and ſtill keeping on the ſame courſe, ſhould return again from the eaſt into the ſame port whence ſhe had ſet out, what would you think of the figure of the earth from *ſuch ſailing round?*

M. If indeed the ſhip ſtill kept the ſame courſe, and yet returned, from the oppoſite ſide, into the harbour whence ſhe had firſt ſet ſail, ſhe muſt, I think, have gone round the whole circuit of the

earth. For (if I may explain my conceptions of this matter by a low compariſon) it is as if ſome little reptile, an *ant* for inſtance, ſhould travel round a wooden bowl in her creeping pace, going off toward the right hand, and returning from the left.

P. Your compariſon expreſſes the caſe clearly, and contracts the tedious voyage of the ſhip into the ſhorter journey of the little inſect. But if the earth were either endleſsly broad, or deep without bottom; or if it reſted on any thing as a *baſis* or *ſupport*, and that *thing* upon another, and ſo on; if, I ſay, that were the caſe, could the earth, think you, be ſailed round? or the ſhip return from the oppoſite ſide into the ſame port?

M. In that caſe, indeed, I do not ſee that either the ſhip could return into the ſame port, or the ſun himſelf go round ſuch an immenſe, ſhapeleſs earth, to the eaſt again, as he does every morning. But poſſibly the earth may be round only about the middle parts of it, that is, towards the *eaſt* and *weſt*, ſo that it might be ſailed quite round there, while it runs out in length towards the *ſouth* and *north*.

P. How far would you have it to run out that way?

M. I cannot tell.

P. It is the intenſeneſs of the cold only, Matho, about the *poles* of the earth, as they are called, that hinders navigators from ſailing round the earth that way alſo; and not the figure of the earth at all: for if we travel to a conſiderable diſtance, either ſouthward or northward, ſtill new parts of the heaven are diſcovered, and ſeem to riſe higher before us, while the parts behind us ſeem to ſink down, and fall under the

earth;

earth; which could not happen, if the earth extended infinitely ſouth and north: nay, on the contrary, which may perhaps ſeem ſtrange to you, the globe of the earth is more plain about thoſe parts, than about the middle of it.

M. You mean it is flatter, or leſs protuberant about thoſe poles.

P. That is it.

M. It may be ſo; but let me conſider a little with myſelf, if I can apprehend the force of this ſecond argument.——It ſeems to be, as if the little inſect I mentioned juſt now ſhould proceed, not from the right hand towards the left, but creep ſtraight forward in a middle path betwixt both; for then it would diſcover ſome new parts before itſelf, and loſe ſight of others behind, in the ſame manner as if it moved in the croſs track.

P. You have it exactly: and hence it is that the ſtar, which is called the *pole-ſtar*, is raiſed higher to us, if we travel northward, and falls lower if we go the contrary way; ſinking gradually as we advance towards the ſouth; for then a great part of the earth's convexity comes between it and us: thus it appears to be raiſed higher to us in Britain, than to thoſe in France and Italy, as our country lies more northward.

M. I conceive it from the example above: therefore, if the cold would allow us ſtill to advance northward, the pole-ſtar would at length appear directly over our heads; and on the contrary, by ſtill retiring towards the ſouth, it would gradually ſeem to approach towards the earth, and at laſt ſink below it.

P. You are perfectly right.

VI. Now from both arguments put together,

(that, to wit, which ſhews the earth to be round from eaſt to weſt, and that which ſhews it to be round from ſouth to north) what ſort of a figure muſt it have, do you think?——

M. But is it certain that it hath been thus ſailed round?

P. It is beyond all queſtion; the Engliſh, Dutch, Spaniards, French, &c. have often ſailed round the globe of the earth: nor hath the voyage for many years back been reckoned a matter of great difficulty.

M. A thing then ſo often performed, cannot, it ſeems, well be denied.

P. Certainly it cannot, unleſs we would expoſe ourſelves by a ridiculous doubting of plain fact; nor therefore can we deny that which is as certain as this navigation itſelf.

M. What is that, I pray you?

P. That thoſe navigators, while they were in the oppoſite part of the globe, beheld the heavens over their head, and ſaw the ſun and ſtars perform their courſes, the ſame way as in their own country; for in all parts *night* and *day* regularly ſucceeded each other.

M. The heavens therefore ſurround the earth on all ſides, it ſeems.

P. Undoubtedly.

M. And the ſun by night ſhines to other mortals.

P. It is ſo; for when he ſets to us, which you agreeably enough called *going behind the mountains*, he riſes to other parts of the earth. And wherever he appears, he makes it *day* by his chearful rays ſpread on that part of the globe, while the oppoſite ſide is covered with *night* and darkneſs.

M. The

M. The ſun then muſt move round the whole earth every day.

P. He ſeems at leaſt ſo to perform his courſe from eaſt to weſt.

M. What, Philon! doth he not really perform this courſe?

P. How things are in reality you will ſee afterward; therefore ſuſpend your judgment at preſent, till arguments determine you to one ſide.

VII. *M.* I ſhall endeavour to obey you; however, be that as it will, you have not yet removed my difficulties: for tell me, are there any inhabitants in that part of the earth juſt oppoſite to us?

P. There either are, or at leaſt may be men directly oppoſite to us.

M. They walk then with their heads hanging downward; in which caſe what can hinder them from falling down all together?

P. How would you, Matho, anſwer that queſtion, if thoſe men argued thus concerning you? For they have the very ſame reaſon to be afraid leſt you ſhould fall off from the earth.

M. It cannot be that any one ſhould *fall upward*, or towards heaven; that would be to be *raiſed on high*, not to fall downward.

P. Very right; now they can give the ſame reaſon, viz. that they could not *fall upward*, or towards heaven; ſince that could only be by being raiſed on high, which you ſay is not *falling*. And ſince the heaven is over their heads, as much as it is over ours, to fall from their part of the earth would be to be carried aloft, as much as it is here with us. In a word, towards the earth is *downward*, and towards the heaven

upward, on whatever part of the globe we ſtand.

M. I know not well what to ſay to this; I have nothing to object to your argument; and yet it doth not convince me.

P. It frequently thus happens, Matho; prejudices which we take early up are not to be overcome in an inſtant, eſpecially if the point be ſuch as we conceive impoſſible to be otherwiſe than it appears to us. But tell me, do you allow that a ſhip may ſail round the earth?

M. Why ſhould I not allow a thing which experience ſhews to be matter of fact?

P. Why therefore are you not afraid leſt the ſhip, while ſhe is in the oppoſite part of the ocean, ſhould fall out of the ſea? Or rather, why do you not ſuppoſe that the water of the ſea itſelf ſhould fly off to the clouds, ſhip and all together?

M. Indeed I think there would be danger of it: and ſince it does not, I want to know the cauſe.

P. What is it that hinders a ſhip in this part of the globe from falling from the ſea up to the clouds?

M. Her weight.

P. And whither doth her weight tend?

M. Towards the earth.

P. Right: now the weight of any thing tends toward the earth, even at the *antipodes*; for ſo they are called who have their feet oppoſite to ours.

M. You ſay then that their weight carries heavy things towards the earth, *all round the earth*; and therefore as much at the antipodes as here?

P. I ſay ſo; and experience ſhews this to be fact, whatever the cauſe of it may be.

M. And

M. And that therefore to tend toward the earth is to *tend downward*, or whatever part round the whole earth the heavy body be placed?

P. Certainly.

M. Nor can we say, if we would speak accurately, that the antipodes are below us, more than that we are below the antipodes?

P. Surely we cannot: for if it requires a force to raise a stone, or any other thing from the earth, *there* as well as *here*; and if it falls back when left to itself, there as well as here; they must say as properly *it falls downward* there, as we say here. And you cannot suppose that our mariners, when in the opposite part of the ocean, feel less difficulty in raising a weight, than here in Britain; or that it would not fall back upon them, if left to itself.

M. Indeed, I see I cannot.

P. No side of the globe then can claim the privilege of being the *upper side*, or reckoning the opposite part the *under side* of the earth.

M. I perceive now, that would be foolish, and seem to myself to have got a better notion: so that if I were in those parts, and arguing with some unskilful boy like myself, who supposed that *we here* were in danger of falling from the ground towards the clouds, I could shew him, that he was in pain for *us* as needlessly as I had been for *them*, since our weight pressed us both equally to the earth.

P. The reason certainly is the same in both cases.

M. Nay, I believe I could hardly forbear laughing at his simplicity; as if we did not walk as securely on the ground here, as they do there. Which I see now would be in effect only laughing

at myſelf, and the ſilly notions I had juſt a few minutes ago.

P. It is not amiſs, Matho, to ſuppoſe ſometimes, that we have thus changed ſides in the queſtion; for we more eaſily perceive our miſtakes, when they are ſuppoſed to belong to another perſon.

VIII. *M.* But tell me, which is the *loweſt place* of all, below which nothing can be?

P. Now you begin to be too accurate, Matho; but you yourſelf will eaſily ſee, that the middle point between us and the antipodes, that is, the very center of the earth, is the loweſt point of all; at leaſt with reſpect to us.

M. For this reaſon, I ſuppoſe, becauſe if there were a paſſage to the center of the earth, a heavy body falling down would be ſaid to *deſcend* thus far; and if it could go beyond the center, it would begin to *aſcend* again, or riſe up towards the oppoſite ſurface.

P. You are perfectly right.

M. But becauſe there is no paſſage to, or from the center, whatever riſes ſtraight upward from the ſurface of the earth, either here with us, or at the antipodes, or in any part round the whole globe, is ſaid to *aſcend*, as if it roſe from the center or loweſt point.

P. That is, indeed, the very reaſon: for anything, by receding from the ſurface, muſt recede from the center at the ſame time, or increaſe the diſtance between the center and itſelf.

M. Thus far I underſtand then, that heavy bodies, by tending to the ſurface on all ſides, muſt therefore tend alſo to the center.

P. And

P. And hence it is that water, which is both heavy and fluid, ſeeks always to a lower place, till it can get no farther.

M. But pray tell me, Philon, what is the cauſe why heavy things tend to the earth, even from oppoſite ſides of it, and by motions contrary to each other? For from what you have already ſhewn me, it follows, that if there were a hole through the whole thickneſs of the earth, as far as the antipodes, and if two ſtones were let down at the ſame time, one from our ſide, and another from the oppoſite mouth of the hole, they would, by the ſame gravity impelling them, run oppoſite to each other, and encounter at the center.

P. Indeed, Matho, if you go on at this rate, I am afraid I muſt bid you farewel.

M. Why ſo, dear Philon!

P. Leſt I ſhould be forced to own my ignorance.

M. I wiſh I were able to bring you to that paſs.

P. I am not very far from it already.

M. I ſee well enough, Philon, what is the meaning of this; you think that I could not underſtand the cauſe of this gravity of bodies.

P. On my word, I had no ſuch thought: but I foreſee you will lead me very deep into theſe matters.

M. We are at the center of the earth already: we can go no deeper than that point.

P. You are diſpoſed to be pleaſant, Matho.

M. To be ſerious then; if you would complete your favour to me, tell me the *true cauſes* of things, as well as the *things themſelves*. If I ſhould not be able to comprehend them, you will loſe only a little labour: but if I ſhould chance

to

to underſtand any thing, that will be a conſiderable gain to me.

P. Well, but let us firſt conſider for a little, from ſome parallel caſe, how bodies thus tend to the earth: that perhaps will bring us nearer the true cauſe, and we may reſume the queſtion at ſome other time. Wherefore,

IX. Tell me; did you ever ſee a *load-ſtone?*

M. Not once, but often; and have frequently tried, by way of diverſion with my comrades, the ſtrange virtue it has.

P. You have obſerved it then to draw the *iron* to itſelf?

M. Yes; and when it had brought it cloſe, it kept it there; ſo that it required ſome force to ſeparate them again.

P. But did the load-ſtone only attract the iron in this caſe?

M. Nay, the iron drew the load-ſtone with equal ſtrength, as it appeared to us: for if the key, with which we made the trial, were kept from moving towards it, the load-ſtone came over the whole diſtance between them, and applied itſelf to the key, ſometimes one way, and ſometimes another.

P. There are indeed ſome ſingularities in this affair; but the iron and load-ſtone attracted each other mutually?

M. That ſeems to be the caſe indeed: and certainly it is a moſt ſurpriſing ſight!

P. And yet ſcarce any thing is more common than ſuch a ſight.

M. How! ſuch a ſight as that common?

P. Did not you yourſelf obſerve juſt now, that two ſtones, let down from oppoſite parts,

would

would ruſh violently to each other through the whole thickneſs of the earth? And that any ſort of bodies, if there were a paſſage for them thither, would run on till they met at the center of the earth? In ſhort, that all heavy bodies move directly to that point, as far as they are allowed to move; ſince they move directly to the ſurface of the earth; of which various motion from all different parts, you ſo earneſtly deſired to know the cauſe?

M. How thoughtleſs I am! But your mentioning the load-ſtone had put the earth quite out of my head.

P. Well then, is it any thing leſs wonderful, do you think, that all bodies round us ſhould ſo violently ruſh towards the ſame point, than that the iron and load-ſtone ſhould move to each other?

M. Truly, when I conſider the matter ſeriouſly, I think it is no leſs wonderful; or rather that it is the ſame wonder ten thouſand times repeated. I know not how it comes to paſs, but we never think at all on the ſubject.

P. Think of it then at your leiſure.——

M. I find I can make nothing out by thinking. If all bodies moved the ſame way, ſuch motion might appear natural to them: but when they ruſh directly againſt each other, how can that be natural?

P. You go rightly to work, Matho: it is a great point gained, *to get a ſight of the wonder*; to be awakened from that ſupine thoughtleſneſs which makes the groſs of mankind look on *things aſtoniſhing* with indifference, becauſe they ſee them conſtantly. Nor is there any thing in nature more aſtoniſhing than this common ſight:

for,

for, that I may obſerve thus much to you by the way, this action in bodies of ruſhing ſo violently all to one point, which we call *falling*, is not the action or effect of matter itſelf.

M. Of what other thing then is it the action?

P. Of what thing do you think?

M. Of ſomething certainly that is not matter.

P. You have hit on a right diſtinction; wherefore let me earneſtly beſeech you, Matho, never to forget it.

M. I do not ſee the great merit of hitting on a diſtinction which was unavoidable: for if this thing, which produces the action of falling in bodies, be not matter itſelf, it muſt neceſſarily be ſomething different from matter. But ſince you ſo earneſtly deſire me to remember it, I ſhall ſuppoſe ſomething of importance is concealed under your requeſt; ſo there will be no danger of forgetting it.

X. *P.* Leaving it therefore at preſent, tell me, if there were many different particles of iron ſcattered up and down, would they not all, think you, meet together from the oppoſite parts round about, by means of the magnet attracting them?

M. It ſeems probable they would *; for they muſt yield to that force which moves a greater quantity.

P. And if there were two or more load-ſtones, would not they likewiſe draw each other?

* Des Cartes has a curious experiment of this; but draws a wrong argument from the appearance. *Si paullo curioſius conſideramus, quo pacto limatura ferri circa magnetem ſe diſponat, multa ejus ope advertemus, quæ hactenus dicta confirmabunt, &c.* Princip. Part IV. § 179.

M. I ſuppoſe they muſt *; and it is reaſonable to think that their force would be increaſed by their number.

P. If then we ſhould ſuppoſe the magnets and particles of iron to be multiplied to any number, or increaſed to any quantity; what do you think would be the reſult?

M. They would all, I ſuppoſe, meet and make up one magnitude or bulk, which would afterwards ſtick cloſe together by the ſame force that brought the parts firſt into contact: for the key and load-ſtone never part, till they are forced aſunder.

P. What if any particle of this bulk were by ſome external cauſe disjoined from the reſt?

M. I imagine it would fall back again, the reſt by their united power retracting it.

XI. *P.* Obſerve how much you have granted me.

M. I do not well know what you mean by this.

P. Conſider with yourſelf a little, whether what we have been ſpeaking of juſt now might not be applied to make you conceive what we were ſpeaking of before, concerning heavy bodies moving towards the center of the earth.——

M. Now indeed I perceive what it is you intend. You mean that the earth attracts to itſelf all bodies in the ambient ſpace; and is mutually attracted by them: juſt as the magnet draws, and is drawn by the ſmall particles of iron.

P. If then all the parts of this our earth were endued with ſuch a power of mutually attracting each other; do you think there would be need of any other *ſupport*, or *foundation*, on which the weight of the whole might reſt?

* See *ibid.* § 152.

M. Let

M. Let me conſider this queſtion a little, before I pretend to anſwer it.—You ſay, *If all the parts of the earth were endued with ſuch a power of mutually attracting each other.* I ſee plainly, by their falling back, that the earth attracts bodies raiſed to any height from it; but it is not ſo plain that *all* the parts of the earth attract each other, when they are at reſt in the earth itſelf.

P. Reflect a little, Matho; does not the ſame attraction, that draws bodies back to the earth, keep them ſtill at reſt there, juſt as it is in the particles of iron ſticking cloſe to the magnet, which you yourſelf obſerved?

M. Pardon this inattention: I ſee it muſt be ſo.

P. Have not all bodies weight, as much when they lie on the ground, as when they are hanging in a balance?

M. They have; otherwiſe it ſhould require no force to raiſe them from the ground.

P. Is what we call *weight* or *gravity* in bodies, any other thing than the conſtant force of this attraction?

M. It is nothing elſe but the force that draws them back to the earth, and keeps them there.

P. Can you ſuppoſe that any bodies through the whole maſs of the earth have no weight?

M. I conceive they all have weight, ſince it would require a force to raiſe them from the place they are in.

P. If then weight be nothing but the conſtant force of attraction; and if all parts through the whole maſs of the earth have weight; is it not the ſame as to ſay that all the parts of the earth are attracted?

M. There

M. There is no denying it.

P. But if each part be attracted, muſt it not be attracted by the reſt?

M. Certainly it muſt.

P. And if this be true of every part ſeparately (that it is attracted, and attracted by the reſt) will not that ſhew, that every part is both *attracted*, and *attracts* the reſt?

M. This queſtion is too intricate for me to ſee through.

P. In this caſe you may ſuppoſe the parts to be great or ſmall: now if you conceive the earth to conſiſt only of two parts, will not each half attract the other, and be attracted by it?

M. Without doubt.

P. And if you conceive three parts in it only, will not each attract, and be attracted by the other two?

M. That is equally plain.

P. Juſt ſo, if you ſuppoſe only four parts in the earth, any one of them is attracted by the other three; and any three of them join to attract the fourth.

M. I perceive now the method; you may go on at this rate for any number of parts poſſible, ſtill proving that any one attracts all the reſt, and is attracted by them. And truly it is wonderful that any the leaſt particle of matter in the earth ſhould attract all the reſt, let them be as many as can be imagined.

P. I am glad, Matho, this obſervation did not eſcape you; the thing is not only wonderful, but *aſtoniſhing*: nor was it ſtrange that you did not perceive, at firſt view, what requires exerciſe and variety of thought to be rightly apprehended. Let me alſo aſk *you this* queſtion, which may

perhaps give you another view of this particular: Can any body be attracted by another, and not mutually attract *that* by which it is attracted?

M. I do not really ſee the neceſſity why a body by being attracted ſhould attract; and yet I believe it muſt be ſo, from what you have ſaid above.

P. Take it thus then: Can a body adhere or cleave to any other body, and yet that other not adhere to it?

M. I ſee the neceſſity in this caſe.

P. But do not bodies adhere to each other by the ſame force that firſt brings them together?

M. They do.

P. Then a body cannot be attracted without attracting, nor attract without being attracted. If the contrary were poſſible, it would require ſome degree of force to ſeparate the *attracted body* from the other, ſince it was drawn by a certain force: and yet it would require no degree of force to ſeparate *that other* from it, becauſe that was drawn by no force: that is, it would require force to ſeparate the iron from the magnet, but no force to ſeparate the magnet from the iron.

M. That is both abſurd in common ſenſe, and falſe in fact. And thus I ſee that any the leaſt particle, by being attracted by the whole bulk of the earth, muſt *neceſſarily* attract that whole bulk, or every individual particle in it: which again ſurprizes me to conſider how *manifold* the *action* muſt be from any one particle, to an inconceivable number of other particles. And I am ſatisfied already, that ſuch *manifold action* cannot be the *work* of the little particle itſelf.

P. You prevent me agreeably, Matho, in making the proper obſervations as we go along. But

tell

tell me, is not the attracting of the whole earth the united attractions of all its parts?

M. It is, as much as the weight of any body is the united weight of all its parts: for as weight does not differ from attraction, ſo neither does the earth differ from all its parts.

P. If the earth then had but half as much matter in it (or half as many parts) would our bodies be equally heavy towards it, as at preſent?

M. They muſt certainly be much lighter.

P. And if it had twice as much matter, would the gravity of bodies be the ſame?

M. They ſhould be much heavier.

P. Can gravity or weight therefore belong to body itſelf, which may be thus leſſened or increaſed, without any change of matter happening to the body?

M. I ſee clearly it cannot, and that the *action of falling* is not the action of the ſtone that falls.

P. But may it not be ſuppoſed to be the action of the matter of the earth, towards which the ſtone falls?

M. It cannot, if the obſervation which I made juſt now, and which you likewiſe approved of, be right: for the ſmall particles, of which the maſs of the earth conſiſts, cannot conſpire from *all places*, towards every *particular place*, to produce gravity in every thing that falls, nay, in every thing that hath weight. To ſuppoſe *every particle* acting *every way* is inconceivable. Such manifold and diſtant actions, as I ſaid, cannot be the *work of* theſe *little things*.

P. You are in the right, Matho, *nothing can act where it is not*; nor therefore can theſe atoms act at thouſands of miles round them.

M. I think now I underſtand the nature of attraction better; only tell me, ſince all bodies in the earth mutually attract each other, why do we not obſerve this in any two bodies; two ſtones, for inſtance?

P. The force whereby they tend to the earth is incomparably greater than that force whereby they tend to one another; wherefore the ſtronger force overcomes the weaker, and renders it inobſervable.

M. I ſee indeed it muſt be ſo.

P. And yet in ſome circumſtances, their attracting one another is perceptible.

M. Pray tell me in what circumſtances?

P. If you take a veſſel of water, and put into it ſome ſmall bits of cork, or other light bodies, not at great diſtances from each other, and ſo as not to diſturb the water in putting them in; you will ſee them attract each other, and meet: and if one piece be conſiderably larger than the reſt, by moving it gently with the point of a pin, you will ſee it draw the reſt after it, wherever it goes.

M. This I ſhall try, as ſoon as I go to my chamber. The ſight muſt be amuſing, and ſeems to confirm what you have ſaid.

P. It does: for though theſe little bodies attract each other when lying at like diſtances on the ground, yet their attraction cannot be then obſerved.

M. It is not to be expected, ſince they have not any liquid thing to ſwim in.

XII. *P.* I ſuppoſe you can now anſwer the queſtion I put to you before?

M. Pray put it again.

P. It

P. It was this, If all the parts of this our earth are endued with a power of mutually attracting each other; in that caſe, would there be need of any other *ſupport* or *foundation*, on which the whole might reſt?

M. I ſee plainly, there would not; for the weight of the whole appears now nothing more, than the mutual endeavour of all the parts to come as near together as poſſible: or, if I may expreſs myſelf ſo, the weight of the whole now diſappears, or tends only to its own center. So that regarding no external thing from without, but only this mutual embrace or contact from within, by that alone it remains firmly ſettled and immoveable.

P. You therefore ſee how this mighty ball of the earth may remain in the free ſpace, without tending to any ſide; *poiſed by its own weight*, as the poet ſays; that is, poiſed by the internal balance of its own attraction.

M. I ſee, O Philon! and that with inexpreſſible pleaſure, this *mighty ball* poiſed in the middle of the heavens, with the ſtars encompaſſing it on all ſides: for many of my childiſh fancies are at once diſpelled. The ſun is not plunged in the ocean, nor pierces through a blind maſs of earth; but travelling unweariedly round, illuſtrates ſucceſſively the oppoſite ſides of the globe, while the ſhades and duſk of night fly before his beams, and only cover the regions which he hath left behind.

P. I eaſily gueſs, Matho, at what paſſes in your mind: to come at a view of the true conſtitution of nature begets a *manly* and *rational pleaſure* in the ſoul, quite different from the pleaſure you find in diverſions, or any other thing.

M. O! they are not to be compared!

P. Likewiſe if the ſun illuſtrates ſucceſſively the oppoſite parts of the globe——

M. The enlightened ſide moves always weſtward: he is but riſing in the eaſt to ſome, while he is already ſetting low in the weſt to others: and it is twelve o'clock to ſome part or other of the earth all the four and twenty hours round.—— But while I conſider in my own mind this ſurprizing nature of attraction, and the inſtance of the load-ſtone and particles of iron, I think I ſee ſomething farther which might be inferred from it.

P. Pray, what is that?

M. May we not conclude that, as all the particles of this terreſtrial maſs, endued with this mutual tendency to each other, make the earth one firm and ſtable globe; ſo the particles of any other leſs body, the load-ſtone itſelf, or iron, for inſtance, having a like force or tendency to one another, make that a ſolid and firm body?

P. You carry your views rightly enough, Matho, from the one caſe to the other: perſons of more years and experience are not always ſo happy.

M. There ſeems to be a ſort of affinity between them, which directs one's mind from the one to the other: for in both caſes leſſer parts, by attracting others mutually, make up a greater body.

P. But what would you ſay, if it were objected that any particle, how little ſoever, is made up ſtill of leſs particles?

M. Provided *all* the particles are endued with this force of mutual attraction, it is of ſmall conſequence, I think, what bulk they are ſuppoſed to be of: for he, who aſcribes attraction to *all* the parts, denies it of *none*.

P. You

P. You are in the right; and there are ſtronger reaſons to be given for this inference of yours, than we can at preſent conveniently enter upon: only in the mean time I ſhall tell you, that the firſt of theſe forces, whereby bodies tend to the center of the earth, is called *gravitation*; and the other, whereby the parts of particular bodies cleave ſo cloſely together, is called the *attraction of coheſion.*

M. I underſtand; for theſe names are appoſite enough, and imply the different effect in both caſes.

P. But are both ſorts of attraction, think you, equally ſtrong?

M. Let me conſider your queſtion a little—— certainly they are not; for I know I can eaſily raiſe a pebble from the ground; that is, I can eaſily get the better of its gravitation: but the firm coheſion of its parts I can neither overcome by ſtrength nor art.

P. But is this coheſion of parts equally ſtrong in all ſorts of bodies?

M. That is to aſk, if *glaſs* and *iron*, or *wax* and *braſs*, be equally firm bodies.

P. To what cauſe then would you aſcribe this coheſion of parts?

M. Not to matter itſelf ſurely.

P. Why ſo?

M. Becauſe if matter cannot do that which is leſs, or effect *gravitation* in itſelf, it can much leſs do that which is greater, or produce in itſelf the ſtronger effort of *coheſion.*

P. It is certain, Matho, both ſorts of attraction are effected in matter by the ſame *immaterial cauſe*, which I hope in time you will diſcover; but there is ſtill another remarkable difference be-

tween them, which it is proper you ſhould be acquainted with at preſent.

M. Pray is it poſſible for me to find it out myſelf, by your aſking me queſtions as you did before?

P. I believe it may; wherefore tell me, do the particles in a ſtone cohere more firmly the larger the ſtone is?

M. I do not think they do.

P. Your reaſon?

M. Becauſe I ſee a ſmall ſtone or piece of iron as hard as if it were ten or a hundred times bigger.

P. Is then this attraction of coheſion mutual between all the particles of ſuch bodies, or only between the particles that touch each other?

M. Only between the particles that touch each other, I ſuppoſe; otherwiſe the hardneſs of a body would be increaſed with its bulk. And now I fancy I perceive the *difference* you intended to acquaint me with.

P. To wit?

M. Whereas the attraction of gravitation is mutual between all the particles of matter in the whole earth, the attraction of coheſion is only between the contiguous parts of bodies.

P. That was the very thing: and as in the former caſe you juſtly admired the infinite multiplicity of action from any one particle to every other atom in the whole terreſtrial globe; ſo——

M. Pray hold, and let me conſider the thing myſelf.——The multiplicity of the action in that caſe is indeed aſtoniſhing and almoſt incomprehenſible: and in this of coheſion it is, I think, equally wonderful, that the action, though ſimple, ſhould yet be exceedingly more ſtrong.

P. There is ſurely an inconceivable art diſcovered to us in adjuſting theſe forces, if we would but reflect: but this likewiſe is wonderful, Matho, that the one ſort of theſe actions doth not interfere with, or diſturb the other. The particles of the iron or ſtone, that have an action directed to every atom in the whole maſs of matter in the earth, and therefore to the very particles in contact with them, have yet a ſtronger action directed to thoſe very contiguous particles, whereby they adhere to each other with almoſt an inſuperable force. And theſe actions, though in the ſame direction, could not be preſerved more diſtinct, if thoſe ſmall atoms had been even large enough to allow pulleys and engines to be fixt to them, and each of theſe wrought by a ſkilful hand.

M. I can hardly expreſs how much you heighten my admiration; and farther confirm to me, that ſuch prodigious force, and diſtinction of degrees, can never be the *work* of theſe little atoms.

P. And then conſider what inconveniencies would follow, if bodies were hard in proportion to their bulk; which would certainly be the caſe, if the latter ſort of attraction were directed from every particle to every particle of ſtone, iron, &c.

M. Indeed then the ſtone in the quarry, or the timber in the tree, would be impenetrable to human induſtry: or contrarily, if bodies were ſoft and yielding, as they are ſmall, artiſts could not only not give their work that curious fineneſs, but there could be no working in *ſtone*, *wood*, or *metal*, without inſtruments exceeding in bulk thoſe materials; which is as much as to ſay, there could be no working in them at all. A *fine edge* or *ſharp point* would ſignify nothing, having the ſoftneſs of wax, or ſomething more yielding.

P. And yet the greateſt part of mankind little think of theſe advantages which we ſolely owe to the *cauſe* which effects this difference of attraction in the ſeveral parts of matter; as if we owed them to *chance*, or *neceſſity*, or *nothing*.

M. That *cauſe* is the thing I chiefly want to be informed of: but if you pleaſe, I would conſider by myſelf, and at leiſure, the ſeveral particulars we have already talked of, before we go farther.

P. It is very proper you ſhould do ſo.

M. But I ſhall take my leave of you only on theſe terms, that we reſume our ſubject after ſome days.

P. If I can be of any uſe to you, you ſhall find me willing at all times.

THE
Second CONFERENCE.

The spherical figure of the earth demonstrated from other arguments: of the usefulness and necessity of mountains: of the magnitude of the earth and moon: of the distances of the moon and sun from the earth. The absurdity of supposing the heavens and whole frame of nature to whirl round in four and twenty hours: that instead of this monstrous conversion, the earth only performs a revolution on its own axis in the same time. The order and periodical revolutions of the planets in the solar system.

XIII. *M.* I Return to you, Philon, a perfect convert to your new doctrine, and value my happiness not a little in having got rid of some of my most childish notions. Almost ever since I left you, I have been thinking of the wonderful property of *attraction*, and the spherical figure of the earth: but I have still a small difficulty with respect to this last point, which I must beg you to remove.

P. Well, Matho! what do you think of attraction now?

M. I can hardly express my admiration of it: without attraction no body could be weighty, or have any degree of firmness and solidity, nay, nor be fit, I think, for any one purpose in nature.

P. What do you think of matter itself?

M. I have already told you, if it were not for this attraction, I do not know what it would be good for.

P. But when endued with the principle of attraction, what are your thoughts of it?

M. It then becomes a *ſolid ſubſtance*; it gives way, or quits its place, if impelled by a ſufficient force, and drives other matter out of its place, when that happens to lie in its way.

P. By what *power* does one body thus drive another out of its place?

M. By its *ſolidity* I ſuppoſe, and not by any power; ſince it is neceſſary that it ſhould be moved itſelf, before it can impel any other body.

P. Could not *body* change place of itſelf?

M. If, as you affirm, it could not ſo much as *fall downward* without ſome *external cauſe* (of the truth of which I am already almoſt perſuaded) I do not think that body, or matter, of itſelf could at all change its place: for *falling downward* ſeemed to me, of all other, the moſt natural action of body. But concerning this external cauſe I have beat my brains long and fruitleſsly to find out what it may be.

P. It pleaſes me, Matho, to ſee you thus ſolicitous to find out the cauſes of things; and I dare engage for it you have not beat your brains in vain. But here I muſt acquaint you, that this want of power in matter is called its *inertia* by the philoſophers.

M. The appellation ſeems proper and expreſſive; for according to my notions matter, conſidered in itſelf, is as *inert* and *ſluggiſh* a thing as can well be imagined.

P. Have you any notion what matter would be, if this power of attraction were not conſtantly exerciſed upon it?

M. Let

M. Let me think a little——I do not know what other people may have, but I am ſure I have no diſtinct notion of it.

P. It is no wonder, Matho; no man ever had, nor ever will have a diſtinct notion of it, only ſo far as it is thus acted upon by an immaterial cauſe: but poſſibly you may come to know more of this afterward.

M. In the mean time then, let us, if you pleaſe, come to the ſmall difficulty that ſtill remains with me concerning the ſpherical figure of the earth.

P. Let me hear what it is.

M. What are we to think of thoſe high mountains, which in many places riſe above the ſurface of the earth, and ſeem not well to agree with its ſpherical figure?

P. Do you call whole mountains, with all their rocks and precipices, only a ſmall difficulty?

M. You, who are to remove it, may give it what name you pleaſe.

P. Right.——Tell me then, have you ever obſerved the ſurface of the ſea?

M. Very often.

P. It doth not riſe above the level of the ſhores?

M. It doth not certainly; otherwiſe the ſea would overflow the dry land.

P. Doth it ſink far below the land?

M. Not a great way; for though in ſome places the coaſt riſes pretty high, yet in going on a few miles you come to a ſmooth and eaſy beach again.

P. Beſides, Matho, the mouths of all rivers are on the ſame level with the ſea, into which they empty themſelves: whence we ſee the *tide*

flows up for a conſiderable way within the land in moſt of them.

M. It is ſo indeed.

P. The ſhores then, if you except theſe ſmall *riſings* and *inequalities*, follow always the figure of the ſea which they bound.

M. I own they do.

P. But what figure do you think the *terraqueous globe* would have, if it were all water, the particles of that element being endued, as they are, with the power of mutual attraction, which we ſpoke of before?

M. Give me time to conſider what effect attraction would have in this caſe.

XIV. *P.* As ſuch a huge maſs of water may perhaps perplex your thoughts, take at firſt only one ſingle drop; you will manage that more eaſily in your imagination: and whatever agrees to it will agree to any quantity of water, how large ſoever.

M. A drop of water juſt ready to fall is, as I have often obſerved, almoſt ſpherical.

P. However, let us imagine that the figure of this drop may be at firſt ſomewhat long, of the ſhape of an egg; and then are there not more particles of water in the length than in the breadth of the drop?

M. Certainly.

P. Is there not therefore a ſtronger attraction according to the length of it, than in the breadth?

M. Without doubt, becauſe there are more particles that attract that way.

P. Muſt not the water, being fluid, yield to the ſtronger attraction, and ſo the drop become ſhorter?

M. This

M. This is ſtill plain.

P. Could the drop therefore remain in any ſettled figure, unleſs all the ſides of it were equally attracted?

M. It could not.

P. That is, unleſs all the particles were at an equal diſtance from the center of the drop, and ſo it became ſpherical?

M. In one drop the reaſon is plain: we cannot imagine that it could have any *corners* or *angles*, or what could keep the particles at a greater diſtance in *theſe*, than in other parts.

P. But is not the ſame reaſon concluſive, to whatever bulk we imagine the drop to grow?

M. I cannot admit that ſo eaſily; for we obſerve they are but ſmall drops which thus become round.

P. What is the reaſon we do not ſee any quantity of water ſettle in a ſpherical figure?

M. I ſuppoſe the attraction is not ſtrong enough to bring all the parts into ſuch a figure.

P. That is not the thing, Matho; but in larger quantities their weight towards the earth ſoon diſturbs and overcomes the attraction between their particles, which hinders a globular figure to take place in them.

M. I perceive it muſt be ſo; or the attraction of gravitation is ſtronger than the attraction of coheſion in this caſe.

P. Imagine then in your mind the earth to be quite removed, and that there is but one drop of water in its place: you will allow this drop muſt be round?

M. I have allowed that already.

P. Suppoſe then it grows ſtill larger and larger to any bulk you can conceive; being no where

attracted from without, and having only this attraction between its own parts from within; what figure do you think the whole mass would put on? Remember *gravity in this case disappears*, or as you yourself said, *tends only to the center of the whole mass*.

M. You have discovered to me the mistake I laboured under. I see in these circumstances, let the drop grow as big as the whole earth, or as twenty earths put together, the reasons you have given for the roundness of one drop will be applicable to the whole bulk. Having no tendency to any side from without, and the parts endeavouring to approach as near to the center as possible from within, a fluid mass will always settle in a spherical figure.

P. For if it had any *corners* or *angles*, any *protuberances* or *heights*, what could keep the water in these parts at a greater distance than in others?

M. Go on, Philon; I own there could be no promontories or mountains in such a bulk of water, more than corners or angles in a single drop.

P. From this mutual attraction of parts therefore, what figure do you suppose this terraqueous bulk would put on, if it were all water?

M. A spherical figure without all doubt.—— But pray let me interrupt you to ask why the *soap-bubbles*, which boys have such a pleasure in blowing up, that they may behold the strange variety of fine colours in them, are all of this spherical figure, whether they be great or small?

P. These bubbles, Matho, are not the diversion of boys only, but also of philosophers; and this their spherical figure is owing to a different cause.

M. To what different cause?

P. It

P. It is owing to the mutual repulſe between the *particles of air:* for this contrary affection ſerves great purpoſes in nature, and proceeds from the power of *the ſame immaterial cauſe.*

M. Tell me but one of *theſe purpoſes* which a mutual repulſe of parts ſerves for, that I may think of it by myſelf.

P. Could you breathe, do you think, in ſuch a cloſe and thick ſubſtance as water?

M. If that were poſſible, no body would ever be drowned.

P. But if the particles of air, inſtead of repelling, attracted each other, they would make a ſubſtance as denſe as water.

M. How do you know that?

P. Becauſe water, when exhaled by the heat of the ſun, or otherwiſe, dilates itſelf into a fluid as light and thin as air.

M. It is ſo indeed; for I ſee the ſteams and vapours riſe up in all ſuch caſes.——Well! it ſeems we owe our lives, not only to the attraction, but to the mutual repulſe between the particles of matter! This is ſurprizing!——Pray tell me now *what cauſe* it is that produces theſe wonderful effects?

P. Suſpend a little, I beſeech you, your enquiry into the *cauſe*, till you are better acquainted with the effects: that is the beſt way to become rightly acquainted with the nature of the *cauſe.*

M. Be it ſo: I am certain your advice muſt be good, therefore I ſhall endeavour to maſter my impatience.

P. To return; you are ſatisfied that a maſs of water as large as the earth could ſettle in no other than a ſpherical figure?

M. I am; for the parts of a fluid muſt eaſily yield

yield to the force of attraction, and not reſt till the attraction can bring them no nearer each other.

XV. *P.* Now if the ſea can only ſettle in a ſpherical figure, and if the earth follows the figure of the ſea, what are we to conclude from thence?——

M. There is ſomething here that ſeems to ſtick with me ſtill. If indeed the whole maſs were water, the point would admit of no diſpute: but the earth may be of a very irregular figure, and covered by the ſea only to a ſmall depth; in which caſe the ſea ſhould rather ſeem to follow the figure of the earth.

P. Think better on the point, Matho: the inequality of the bottom doth not at all affect the ſurface of any liquid, or make that uneven or irregular, which you may be ſatisfied of from the moſt common inſtances. The bottom of a pool may be rugged and uneven, but the water on the top is always ſmooth.

M. Pardon my inattention; I did not reflect that the reaſon is the ſame in large as in ſmall quantities of any fluid: but now I perceive, if the ſea were ſo deep as to cover the tops of the higheſt hills, the heights under water could make no *ſwellings* on the ſurface; and then this univerſal ocean would be truly ſpherical.

P. For you remember *there could be no promontories or mountains of water.*

M. If I do not, I find you do: but I deſerve to be thus twitted.

P. If then the ſea quite ſurrounds the whole earth, which our navigation in this age leaves no room to doubt of (though perhaps the coaſts and ſhores may not go on in a ſtraight line, but wind

out

out and in irregularly enough) the whole ſurface of this continued ocean cannot be other than ſpherical; and therefore the whole terraqueous maſs muſt be of a ſpherical figure, ſince the higheſt parts of the dry land are raiſed above the ſurface of the ſea, but to a ſmall height, if compared with the vaſt bulk of the whole earth.

M. I perceive at laſt the ſeveral parts of your argument meeting together, and concluding the thing to the ſight of the eyes.

P. If we ſhould ſuppoſe the ſea only four or five miles higher than it is, it would cover the tops of the higheſt hills (as you were ſaying:) and if we imagine it to ſink down again to the preſent limits, we ſhould indeed ſee, as it were with our eyes, the preſent figure of the whole terraqueous globe to be next to ſpherical: for four or five miles are but a ſmall matter in reſpect of ſeveral thouſands.

M. And from this——

P. Go on.

M. From hence I think it will follow that the ſurface of any pool, or ſtagnant water, is a portion of the ſpherical ſurface of the ocean.

P. It is perfectly well obſerved, Matho; for water, in what quantity ſoever, always ſettles on the ſurface to the equality of attraction, as if there were no ſolid ground near it: and if there were not, it would really become a part of the ſpherical ſurface of the ſea, raiſed to that height, though to the ſight of the eye it appears plain.

M. I conceive it fully; any ſmall part of the ſurface of the ſea, a mile round for inſtance, appears to the ſight a level plain.

XVI. *P.* Now to return to the ſubject with which

which we began, *the heights and inequalities of the hills*; to wit, if the terraqueous globe were accurately ſpherical, would it have the ſame advantages it has at preſent?

M. I am at a loſs to know in what reſpect; make your queſtion, if you pleaſe, more particular.

P. If the earth were perfectly ſpherical, how could the water of the ocean diſpoſe itſelf?

M. O! I have it. The water of the ſea would then cover the whole face of the earth to ſome height or other; or it would then be equally ſpread over the ſurface of ſuch an accurately ſpherical globe: and there being no dry land, our globe could only be in that caſe a habitation for *fiſhes* and *ſea-monſters*. I perceive unſpeakable advantages on the ſide of the preſent figure of the earth.

P. But if the ſurface of the ſea were ſunk a mile or two below the land, and the reſt of the globe of a perfect ſpherical figure, only thus much higher, would that diſpoſition of things have any convenience or inconvenience above the preſent?

M. From the former caſe I foreſee what would happen in this. If there were any water at all on this higher part of the globe, it muſt cover it all equally: if there were none, the dry part of the earth muſt then be *dry* indeed, without rivers or running waters, to the great inconvenience of *man* and *beaſt*.

P. It is ſo; for that the earth may be fruitful, and produce herb for the uſe of man and beaſt, it muſt abound with ſprings and running waters: nor could there have been a *deſcent* for *rills*, *brooks*, and *rivers*, unleſs from ſuch heights and inequalities as we ſee at preſent; which, being ſo moderate, neither deform (nor hinder the deſign of) the ſpherical figure of the earth; and yet make

the

the dry land a comfortable habitation for man, and all creatures that have the breath of life.

M. I ſee now the ſurprizing *art* and *contrivance* of nature! the uſe and beauty of thoſe inequalities, which before I looked upon only as a *mere negligence!*

P. And hence it is that mountains are ſupported with firm and unyielding rocks, as it were with bones, that they may ſtill preſerve their *heights*, which are ſo neceſſary. *Soft* and *yielding* mountains of *clay*, or *pure mold*, muſt, by ſinking down, have in time filled all places with dead waters, or ſtinking puddles.

M. How raſh *are thoſe men*, who fancy that the mountains are only *blemiſhes* of nature, and good for nothing!

P. The man who criticiſes on the works of nature, Matho, challenges pretty plainly to himſelf a ſuperiority of knowledge over the *author* of *nature:* a folly which a ſober perſon will hardly be guilty of. Mountains to the eye may ſeem rough and diſagreeable; but whoſoever will reflect on their internal ſtructure, muſt own it is a piece of work deſigned by art, no leſs than the body of an animal. For the internal parts muſt be *firm* and yet *open*, or at leaſt not cloſe and denſe matter, that they may admit into their cavities the rains and water falling from the ſky: nor muſt the *cæleſtial ſtore* ſtagnate there, but perform a various and mazy courſe, till it breaks out again into the open air, at the ſides and roots of the hills: whence it flows in winding ſtreams to enliven the parched ſoil, and chear the thirſty tribes of animals.

M. Methinks I ſee all this various contrivance wrought in the dark bowels of the mountains.

P. In this caſe, Matho, we ſeem not to have a taſte for *great beauties*, but for little affected nicеties. It is as abſurd to expect that the mountains, wrought by nature's hand, ſhould have the ſmooth, pitiful figure of a *garden-mount*, as to fancy that a ſhip's anchor muſt be wrought with the finery of a trinket in a toy-ſhop.

M. You have certainly, Philon, given me a juſt taſte of the beautiful variety of *plains*, *hills*, and *valleys*; of which I remember the *poet* ſays,

Juſſit et extendi campos, ſubſidere valles,
Fronde tegi ſylvas, lapidoſos ſurgere montes.

It is ignorance or inattention only which make men imagine, that the earth would be either more beautiful, or more convenient, if there were no hills.

P. The views of men are too narrow, Matho, when they would paſs a judgment on the great works of nature. For the weight of the large tracts of mountains in the ſeveral parts of the earth muſt exactly balance one another, for a reaſon which poſſibly you may diſcover afterwards; and their height and bigneſs muſt anſwer to the ſpacious plains they are to water below.

XVII. *M.* Since now I preſume I am pretty well ſatisfied about the figure of the earth; pray what are we to think concerning the figures of the other remarkable bodies of the univerſe: the ſun, moon, and ſtars, I mean?

P. What do you imagine of their figure from the appearance they make to the eye?

M. If I conſider their appearance, the ſun and moon ſeem rather to be *flat* and *circular*, than *ſolidly globular*.

P. If

P. If you were to ſee a wooden globe ſuſpended at a conſiderable diſtance, how would it appear; flat and plain, or convex and ſpherical?

M. If it be too far removed, the convexity of it diſappears, and it ſeems only plain and circular, like a trencher.

P. It is ſo; the greatneſs of the diſtance makes the convexity imperceptible, and a ſpherical body appears only like a plain circular ſurface. Now ſince a ſpherical body makes this appearance at a great diſtance, what figure would the earth appear of to a ſpectator removed from it to the diſtance of the moon or ſun?

M. For the ſame reaſon it muſt appear plain and circular.

P. It certainly muſt; for the ſhadow of it, when *that* falls upon the moon, is always circular; and the earth itſelf could have no other appearance, at that diſtance, than of a flat circular body.

M. Explain a little, if you pleaſe, how the ſhadow of the earth falls upon the moon; becauſe, if left to myſelf, I ſhall fall into ſome wrong notion about it.

P. There is no myſtery in that affair at all, if this were the proper place to ſpeak of it: however, I ſhall tell you thus much by the way, the earth caſts always a ſhadow on that ſide which is turned from the ſun, juſt as a ball does upon the oppoſite wall, if a candle ſhines on the other ſide of it.

M. So far I underſtand; for it is this ſhadow caſt by the eaſt, when the ſun is on the oppoſite ſide, that makes it night; when the ſtars appear, and the moon ſhines with all her ſplendor.

P. You will likewiſe obſerve, if we come to

ſpeak

ſpeak of the ſyſtem of the planets, that the moon, when *full*, is directly on the oppoſite ſide of the earth to the ſun.

M. I have indeed obſerved it ſo: for the *new moon* is never far from the ſun, but always removes to a greater diſtance from him, as ſhe draws nearer the *full*.

P. It happens ſometimes then, that ſhe muſt enter into, and paſs through the ſhadow of the earth, when ſhe is ſaid to be *eclipſed*.

M. I have heard of the moon's being eclipſed, and ſeem now to underſtand the cauſe of it.

P. In the *eclipſe*, as the moon enters into the ſhadow of the earth, it looks as if a black circle were coming over her: for her ſurface appearing plain, the part of her obſcured is always circular.

M. This is not difficult to be conceived: I could repreſent the moon by a circle of white paper, and the *ſhadow* by a large circle of black paper gradually intercepting the view of it.

P. You might: and from this appearance we may again conclude with certainty, that the figure of the earth is ſpherical.

M. Pray ſhew me how you draw that concluſion?

P. You will ſee it thus. Since the ſhadow of the earth, which the moon paſſes through, falls ſometimes from one ſide of the earth, and ſometimes from another, and yet ſtill appears circular on the moon's ſurface, either as ſhe enters into it, or comes out of it; it is plain the body which caſts this ſhadow muſt be ſpherical. For if in any poſition of a body, the ſhadow it caſts upon an oppoſite plain ſurface be ſtill circular, that body muſt be *every way round*, or ſpherical.

M. This

M. This I eaſily conceive, from having often diverted myſelf with the ſhadows of things on the wall: for if the ſhadow of a ball and of a flat circular body, like a piece of money, fall upon a plain part, the ſhadow of the ball is always round; but if you turn the *edge* of the circular body to the light, the ſhadow becomes a ſtraight line. But how does the ſhadow of the earth fall ſometimes from one ſide of it, and ſometimes from another?

P. You may remember you ſaid before, that it is twelve o'clock to ſome part or other of the earth, all the four and twenty hours round.

M. I did; and that when it is mid-day to us, the ſun is but riſing to ſome that are weſt of us, and already ſetting to others that are eaſt of us.

P. The ſun therefore is always riſing and always ſetting to different parts of the earth all the twenty-four hours round.

M. It is ſo.

P. The enlightened half of the earth then, always veering about weſtward, the ſhadow muſt be caſt by different parts of the earth's ſurface. You find it is ſo in the example you mentioned juſt now; for whether you turn the ball round before the candle, or carry the candle round the ball, different parts of the ball will be enlightened, and therefore the ſhadow formed by different parts of its ſurface.

M. The matter appears to me now extremely plain. Only tell me why the ſhadow of the earth doth not eclipſe the ſtars as well as the moon?

P. It ends in a point, before it can reach any of the other heavenly bodies.

M. Pray, how is that?

P. You will lead us from our purpoſe, Matho; however,

however, as you have ſometimes diverted yourſelf with projecting ſhadows on the wall, you will eaſily apprehend the caſe.

M. I am glad of having diverted myſelf ſo, if that will help me to underſtand theſe things.

P. If the body, whoſe ſhadow is projected, be bigger than the *luminous body*, the ſhadow grows always larger, the farther it goes.

M. That I know; having ſeen my own ſhadow of a gigantic ſize.

P. If the ſun then were leſs than the earth, its ſhadow would ſtill grow larger, and reach out to an infinite length: but if, on the contrary, the ſun be larger than the earth, its ſhadow muſt grow always leſs, and at laſt end in a point.

M. So then it ſeems the ſun is larger than our earth? I am glad to have diſcovered that ſo eaſily, and ſhall not trouble you farther with my queſtions on that head.

XVIII. *P.* To return then to the figure of the other cœleſtial bodies; ſuppoſing the ſun and moon are vaſt ſpherical bodies, like our earth (and you have ſeen already the ſun is bigger) and that they are placed at a great diſtance from us; what ſort of a figure, think you, muſt they appear to have, when ſeen from hence?

M. They muſt, by what you have ſhewn me before, appear *flat* and *round*, not *ſpherical*.

P. And ſince they actually appear flat and round, what figures muſt the bodies themſelves really have?

M. A ſpherical figure, I ſuppoſe: and beſides, it ſeems ſome way or other unnatural to imagine them *flat* and *thin* bodies.

P. That fancy would be whimſical enough:

but what you say is confirmed from this consideration, that some of the cœlestial bodies (and among these the *sun himself*) are constantly turning round on their axis (as it is called) and so shew successively all their different sides to us; and since in every position they appear round, the figure cannot be other than spherical.

M. That circumstance, indeed, puts the thing out of doubt: for if the sun were a flat thin body, upon turning his edge to us, he would appear (like the circular body we just now spoke of) a *long bright line*; which would be an odd sort of a figure for the sun. But leaving the sun and moon, of what figure are the other cœlestial bodies?

P. Some of these too, I have told you, are discovered to turn round on their own axis, and still appear circular.

M. These therefore are *large globes*, I suppose.

P. They certainly are.

M. What is the reason then, that none of them appear so large as the sun and moon?

P. You know, Matho, *a house at six or seven miles distance could hardly be seen; or at best appear very small.*

M. Good: however, I know now that the sun is larger than a house.

P. But tell me, if the sun were still removed to a greater distance from us, or (which comes to the same thing) we carried to a greater distance from him; how would he appear from this change of distance?

M. He would still appear less and less.

P. And if he were thus removed *without end*, what would follow?

M. He would, in time, appear only like one of the biggest stars, and afterward like one of the smaller;

ſmaller: and certainly, if he removed *without end*, we ſhould at laſt loſe ſight of him altogether.

P. It is ſo; ſmall bodies, by increaſing their diſtance, ſoon diſappear; and the largeſt muſt do ſo too.

M. But I think I have obſerved a difference in this caſe, between *ſhining* and *dark* bodies: *a candle* is ſeen at a great diſtance in the night-time, while a larger body, though in the ſtrongeſt ſun-ſhine, cannot be ſeen near ſo far by day.

P. Your obſervation is extremely juſt: bodies that are ſeen by their own light pierce far, while bodies that are diſcerned only by the light of another, ſtrike the eye leſs forcibly. And it is quite inconceivable, at what immenſe diſtances ſome of the *ſhining bodies* in the ſky are placed from us. Which things it may hereafter be of great uſe to you to remember.

M. When there is occaſion, I ſhall eaſily call them to mind.

P. As to the other part of your obſervation, it is a very neceſſary condition of ſeeing a *lucid body* at the greateſt diſtance, that no light ſtrike the eye but its own. All the ſtars, you ſee, diſappear by day; and the leſſer are not eaſily ſeen when the moon ſhines bright. And if there were an intenſe darkneſs, ſtars that now eſcape the quickeſt eye would be diſcerned.

M. In looking up to the heavens in a ſtarry evening, Philon, I have often admired with myſelf, the immenſity of *that ſpace*, and fatigued my imagination, to find out if it had any limits; and what you ſaid juſt now of the ſun's being *removed without end*, brings it to my mind again: pray could a body *move on endleſsly?*

P. Why not? as well as *the earth be ſtretched out endleſsly in breadth?*

M. That

M. That was only an inconſiſtent notion of mine: but could a body move ſtraight forward for ever, without finding any thing to ſtop it?

P. Nothing could ſtop it, unleſs it were another body.

M. And could it move on thus to any ſide?

P. To any ſide, to which you can ſuppoſe it to move at all.

M. This is extremely ſurpriſing! Pray is there nothing in all this *infinite room* or *ſpace*?

P. If there be nothing in it, then *nothing* would be infinite, while *ſomething* is but finite.

M. You ſpeak too conciſely; pray direct me how to think in this caſe.

P. It is too ſoon for you to enter on this ſpeculation.

M. Remember your own words, Philon.—— *The plain and ſimple truth is to be laid open to young perſons, as ſoon as they begin to turn their thoughts to any ſubject.*——

P. You puſh me unaccountably, Matho! However, as you have ſtarted that thought, which naturally leads young minds to their firſt notion of infinite; all that is neceſſary for you to know at this age is, that ſome *poſitive thing*, *ſome being*, muſt be infinite: for that *emptineſs*, or *void*, or *pure nothing*, ſhould be infinite, is both abſurd and impious.

M. But may not matter be infinite?

P. What is matter abſtracted from the principle of attraction we ſpoke of before?

M. I owned to you then, *I had no diſtinct notion of it, without that principle:* all that remains, abſtracting from that, is ſome *ſluggiſh dead thing.*

P. How would it ſound, to ſay *infinite deadneſs*, *infinite inactivity*?

M. As ill, I think, as *infinite emptineſs*, *infinite nothing*.

P. If then matter, informed by this principle, were infinite, that would neceſſarily ſuggeſt to us *a prior*, and *nobler infinite* than matter; ſince you have already perceived, from ſome good reaſons, that attraction is the power of an *immaterial cauſe*. And though any man could have a notion of matter without *that principle*, whereby it can only become a ſolid ſubſtance, *ſuch a thing* infinite could only be *infinite inactivity*, *infinite want of power*. But for other reaſons matter cannot be infinite. And at any rate to ſuppoſe it ſuch, is either ſuppoſing a contradiction, or allowing a prior and nobler infinite.

M. I have even ſome notion of this, ſo far as it depends on what you ſhewed me before; and I am ſure it is better to have heard it, than to be left to the uncertainty of my own thoughts. But ſince ſome *poſitive being* muſt be infinite, may we not enquire into the nature of that *nobler*, *prior* infinite?

P. O! by all means; let it be the buſineſs of your life: but if you have a notion how abſurd *infinite deadneſs*, *infinite inactivity* is, endeavour to get a notion of *infinity of power*, *infinity of life*, *infinity of knowledge*: for what is infinite muſt be infinite in perfection, *in all perfection*.

M. I perceive, if I ſhould ſay *infinite deadneſs*, or *infinite weakneſs*, that would render *life* or *power* impoſſible; becauſe there could be no room for the *perfection*, *if the imperfection* were infinite.

P. Cheriſh this notion, Matho; infinity itſelf is the greateſt perfection, and moſt people are not aware of the abſurdity of joining it to mere negations. I have now nothing left to add on the ſubject.

XIX. *M.* Will

XIX. *M.* Will you give me leave then to propoſe a thought to you concerning the ſubject we were upon before?

P. I ſhall liſten to it with great pleaſure.

M. When I conſider this ſpherical figure of the cœleſtial bodies, and how unnatural it is that any of them ſhould have been *thin* and *flat*; and when I reflect on that attraction which obtains through the whole bulk of the earth, which naturally produces a roundneſs of figure in any maſs of matter; I begin to think that this property of attraction is no leſs prevalent in the *bodies above*, than in our globe.

P. The thoughts are very naturally joined together, Matho; and no leſs ſolid than ingenious: for do you ſtill remember your own obſervation?

M. What?

P. That without this attraction no body could have been weighty, or have had any degree of firmneſs and ſolidity; nay, nor have been fit for any one purpoſe in nature?

M. I do.

P. And you ſtill allow *that this attraction is not the work of matter itſelf?*

M. That I am more and more perſuaded of: for how could a particle act at a diſtance? Nothing can act but where it is. Or how could it act ten thouſand different ways at once?

P. Matter could not then be *ſolid ſubſtance*, or adhere one particle of it to another, without attraction?

M. It could not.

P. We muſt allow attraction therefore in *thoſe bodies*, as they are ſolid ſubſtance, abſtracting from their figure?

M. I ſee it plainly; we muſt. And not only there, but every where elſe. This conſideration makes the attraction of coheſion univerſal.

P. And then as to gravitation; the particles of matter in thoſe bodies could not have fallen into this ſpherical figure of themſelves; ſince *motion*, *change of place*, and *falling downward* (that is, towards a center) all proceed from this attraction.

M. All this is ſtill freſh in my mind, and I diſcover now the truth of that which I thought at firſt was only a probable conjecture. Without attraction the particles could never have come into this ſpherical figure; unleſs we ſhould ſuppoſe that ſome *unknown being* had at firſt laid them all in this round form.

P. That muſt have been a painful and tedious taſk, Matho; but even this extravagant ſuppoſition is inſufficient, ſince the leaſt force might have diſordered them again: for attraction is as neceſſary to preſerve a ſpherical figure, as to form it at firſt.

M. I have ſome conception of what you ſay; but explain it to me a little, if you pleaſe.

P. *Body* could not have weight if it were not attracted.

M. Surely not, ſince weight is only the force of this attraction acting conſtantly.

P. Water could not tend to the lower ground if it had no weight, nor change the figure it ſhould at any time be put into.

M. That is undeniable.

P. You might build water then, or rather lay it in the form of a *wall*, a *houſe*, a *pyramid*, any thing you pleaſe to imagine; it could not move from the place in which you laid it.

M. The thought is ſurprizing; and yet there is no denying the conſequence! I ſee water could

not

not be water without this attraction: I could mould it into any figure: nay, I could lay a quantity of it as high as I could reach over my head, and it would remain there. This is all wonder! What ſhould we drink! I thought water had been neceſſarily water.

P. All the water in the ſea therefore, or all the matter in the earth, might be laid in the form of a flat thin body, or diſpoſed of in a huge length, or in many other ways we might conceive; and it could never more return to a ſpherical figure again.

M. You ſatisfy me abundantly, O Philon! that attraction is as neceſſary to preſerve a ſpherical figure in the great bodies of the univerſe, as to bring them into it at firſt. I am overjoyed to find this attraction as univerſal as it is wonderful. It is ſalutary to us ſo many ways; and a kind of preſervative, I think, to the whole frame of nature.

P. You will I hope have greater reaſon to ſay ſo hereafter.

XX. *M.* Now ſince the earth is bounded every way, and of a ſpherical figure, is it known how large the globe of the earth is?

P. This is known pretty exactly; but if you would be informed of any thing about its magnitude, you muſt firſt underſtand the names and poſitions of ſome circles, that are imagined to be on its ſurface, and are painted on this artificial globe; becauſe it is by the help of theſe they have meaſured the earth.

M. Pray make me acquainted with them: I have often admired theſe lines, without knowing any thing of their uſe.

P. Theſe two points are called the *poles* of the earth; this here raiſed above the wooden frame is called the *arctic*, or *north pole*; it points to the pole of the heaven ſeen by us. The other ſunk below is called the *antarctic*, or *ſouth pole*; it points to the oppoſite part of the heavens, which we in this part of the earth never ſee.

M. You named theſe poles before I remember, and ſpoke of the *pole-ſtar*: but why are they called *poles*?

P. Becauſe they are as it were the *hinges* on which the earth, according to ſome, or the heavens, according to others, turn round in twenty-four hours.

M. This Engliſh name ſuggeſts to me their uſe, becauſe any thing may be turned on its hinges.

P. You will obſerve then that the poles themſelves do not turn round.

M. So I perceive by turning round the globe.

P. The line which joins the two poles is called the *axis* of the earth.

M. I know very well what an axis means, and what the uſe of it is.

P. This circle equally diſtant from both poles is called the *equator*.

M. The reaſon of its name is obvious.

P. All theſe circles which you ſee cut the equator, and meet at the poles, are called *meridians*.

M. Why are they called meridians?

P. The word you know ſignifies ſomething belonging to the *mid-day*. Now, when the ſun comes to *our meridian*, for inſtance, he makes it mid-day, or noon, to us; being equally diſtant from eaſt and weſt.

M. I conceive it; and when he goes farther weſt,

weſt, he makes it twelve o'clock to another place, and ſo on quite round: and ſince, as we have ſaid before, it muſt be twelve o'clock to all places round the globe in four and twenty hours, there are many meridians; for every place muſt have its own meridian, which has twelve o'clock at a different time.

P. This readineſs of yours, Matho, ſaves me a great many words, which I ſhould be forced to uſe with ſome of your age.——We may conſider the other circles on the globe hereafter, if there be occaſion: but you muſt know that every circle is divided into three hundred and ſixty equal parts, which are called *degrees*.

M. I obſerve indeed the æquator on this larger globe ſo divided, as alſo the great brazen circle divided into four nineties.

P. You muſt likewiſe know that the point of the heavens juſt over the pole of the earth doth not ſeem to move.

M. Becauſe, I ſuppoſe, the whole heavens ſeem to turn round on that point.

P. And therefore they ſeem to turn round the *pole-ſtar*, though a little diſtant from it. And this you may eaſily obſerve yourſelf in the heavens any evening: for you will ſee all the ſtars change place with reſpect to you, except the *pole-ſtar*, which ſtill keeps at the ſame height above you.

M. I have obſerved the reſt to move weſtward; but know not the pole-ſtar, which I beg you would ſhew me ſome evening.

P. I will whenever you pleaſe. Laſtly, you may obſerve almoſt the ſame circles on this other globe, which is called the *cæleſtial*: for they ſuppoſe the *convex* ſurface of the earth, and the *concave*

ſurface of the heaven, to be divided nearly the ſame way.

XXI. Now, Matho, if any perſon ſhould go round the earth on one of theſe meridians, that is, if he ſhould go over the whole three hundred and ſixty degrees of this circle, muſt he not diſcover the whole concavity of the heaven *by degrees?*

M. He muſt, by going round the whole earth from *ſouth* to *north.*

P. That is, would he not diſcover all the 360 degrees of the *cæleſtial meridian*, which is over the *terreſtrial*, one degree after another?

M. He certainly would. This is eaſily conceived from what you ſaid before, when you ſhewed me that the earth was ſpherical from ſouth to north, as well as from eaſt to weſt: for if a man ſhould go one degree forward to the north on the terreſtrial meridian, one degree of the cœleſtial meridian muſt ſeem to riſe above the earth before his eyes; and a degree of it likewiſe muſt ſeem to fall below the earth behind him; and ſo on; a new degree would ſeem to riſe before, and another to ſet behind him, through all the three hundred and ſixty degrees. This is the ſame caſe with the *ant* and the *wooden bowl.*

P. You make the application juſtly enough. But from the different elevation of the *pole*, or of ſome other ſtar, mathematicians know very well when they have gone over a degree of the terreſtrial meridian, or one three hundred and ſixtieth part of the whole circuit of the earth. And different perſons have carefully meaſured, both here in England and in France, how much this three hundred and ſixtieth part of the earth's circuit comes

comes to, their ſeveral calculations agreeing to a very trifle. Thus the figure of it being ſpherical, they have diſcovered how much the whole circuit of it is, and given in common meaſure the greateſt thickneſs of it, or the length of a line from the one ſide to the other, which is called the *diameter* of the earth.

M. Pray how long may this diameter be?

P. It is little leſs than eight thouſand miles.

M. So far, therefore, are we diſtant from the antipodes.

P. We are.

M. This is a prodigious maſs to be ſuſpended in the *empty æther!*

P. Does it yet ſeem wonderful to you, that the earth ſhould be ſuſpended in the empty æther?

M. No; you have corrected my notions concerning that; but I fall inadvertently into the common ways of ſpeaking. The mutual attraction of the parts makes the whole weight of the globe tend inwardly to its own center: ſo that it is of no conſequence, whether the body be ſmall or great, provided this attraction be directed to nothing from without.

P. To be ſuſpended therefore is an improper expreſſion, and ſerves only to miſlead our thoughts, as if *body* tended naturally, and of itſelf, to one ſide more than to another. It is more juſt to ſay, *bodies are placed* in the ambient ſpace, than that they are *ſuſpended* in it.

M. You told me before, I remember, *That toward the earth was downward, and toward the heaven upward, on whatever part of this globe we ſtand.*

P. I did.

M. And that *the center of the earth was the loweſt point of all, with reſpect to us.*

P. It is ſo.

M. I perceive from what we have ſaid juſt now then, that it muſt be ſo on any other great body of the univerſe. Towards its center is always *downward*, and its center muſt be the *loweſt point*, with reſpect to the weight of any body placed on it.

P. There is all the parity of reaſon for this, there can be for any thing.

M. This diſcovers to me the foundation of my firſt prejudice: for I thought there was an *univerſal downward* (if I may ſay ſo) with reſpect to the whole infinity of ſpace, and an *univerſal upward*, that were unchangeable; or that all bodies naturally tended one way. Whereas I now find that *downward* and *upward* change, both with reſpect to the oppoſite ſides of the ſame great body, and with reſpect to the different great bodies of the univerſe.

P. You are right. *Downward* is only a relative term with reſpect to the center of any of thoſe great bodies: for when a ſhip ſails round the earth, it would be ridiculous to think that your *univerſal downward* turned upward, that is, the contrary way, when ſhe came to the oppoſite ſide of the globe; or that *downward* and *upward* rolled round the whole earth, and the whole heavens too, as the ſhip advanced on in her courſe.

M. That would be a monſtrous fancy indeed.

P. That you may perceive the abſurdity of it more clearly, let us, if you pleaſe, ſuppoſe, that there was a time when there was no body at all in the infinite ſpace; and then try if you can imagine a *downward* or an *upward* in theſe circumſtances.

M. I

M. I find I cannot.——*Down*——towards what? Or *up*——towards what? No; *down* and *up* are vaniſhed now.

P. Down and *up* are not abſolute then?

M. Moſt certainly they are not.

P. Suppoſe again that only *one body* exiſted in nature, as the earth, or the ſun; will *upward* and *downward* begin to appear in that caſe?

M. Not an *univerſal downward* and *upward* more than before: there will only be a *downward* with reſpect to the center of this body, and *upward* from it.

P. Imagine there were two ſuch bodies in the immenſe ſpace: will theſe give riſe to *abſolute downward* and *upward?*

M. No, though we ſhould ſuppoſe ever ſo many. *Theſe* are nothing in themſelves, only mere external denominations.

P. It is ſo; they are nothing real; and it is ſtrange that the generality of men ſhould give them a reality in their own notions. If they were *real*, they would occupy or belong to the whole immenſity of ſpace, and be antecedent to the exiſtence of matter. Hence then tell me, do bodies tend naturally and of themſelves to any one ſide more than another?

M. They do not: here was the prejudice I laboured under, I now ſee to the bottom of it.

P. Can *gravity* therefore, or *weight*, or *tending to any place*, or *motion of any kind*, belong to the nature of body or matter?

M. I perceive, dear Philon, from this familiar and convincing argument, they cannot; and that all theſe *(motion, weight, tendency)* are the immediate impreſſions of that IMMATERIAL CAUSE, with which you have not yet been pleaſed to ac-

quaint me. But it gives me great ſatisfaction to have come at this different view of ſuch an agreeable truth. And if this remains a general prejudice even among men, how eaſy were it to throw the childiſh notion of an *abſolute downward* and *upward* out of their minds? It likewiſe gives me pleaſure to think how acceptable the diſcovery of this truth will be to my companions. For I will endeavour to communicate all theſe things to them, and try to deal with their prejudices as you have done with mine.

P. Your deſign proceeds from a right diſpoſition, Matho: there is not a more generous and rational pleaſure than that of communicating knowledge and truth to another rational being: nor can any method be more effectual to rivet theſe things *deep in* your own mind, than by caſting about to find out the beſt way to make others conceive them.——

M. As to the method of meaſuring the earth, I have a notion of it in general: the hardeſt things muſt have a beginning, and become familiar by degrees: pray go on therefore as you begun, to tell me things as they really are: though they may be above my reach, ſomething will ſtill ſtick with me. Wherefore,

XXII. Pray inform me how far the moon is diſtant from us?

P. Have you any thoughts of making a trip thither?

M. I wiſh the thing were practicable.

P. The length of the journey, I am afraid, would diſcourage you.

M. How far may it be?

P. After we know the length of the earth's ſemi-

semidiameter, and the angle which that subtends at the moon, by two lines drawn from its extremities to her center, it appears that her distance from us is about 60 of these semidiameters, or nearly 240000 miles.

M. That is indeed a journey not to be made in the space of one night: and in the day-time there is scarce any finding one's way, which is somewhat singular. But how large a body may the moon be, if compared with our earth?

P. The diameter of the earth is near four times longer than the diameter of the moon; which (among other methods) is known from the breadth of the earth's shadow, where the moon passes through it.

M. That is to say, three or four moons might be contained in it at one another's sides.

P. You are right. Whence the face of our earth would appear about fifteen times bigger to a spectator at the moon, than the face or *disk* of the moon (as it is called) appears to us here.

M. How can it appear fifteen times bigger? It should only appear, I think, three or four times bigger.

P. You will naturally imagine so, Matho, till you are better skilled in these matters. But here is a figure of the very thing we are speaking of. This larger circle, which represents the breadth of the earth's shadow where the moon passes through it, contains the lesser you see, which represents the moon more than three times; yet the *first* is much more than three times the *last*.

M. I find I was quite mistaken; yet I might easily have rectified myself, by imagining the figures drawn.

P. This will surprize you more; if a body like

like a *dye* hath its ſide twice as long as another of the ſame ſort, it will be equal to eight times that other: which may be ſeen by cutting any ſoft body into ſuch ſhapes.

M. I have almoſt a notion how a piece of apple, or turned, might be ſo cut, as to make eight ſuch ſmall dice out of a larger one.

P. I preſume you are not altogether a novice at this work.

M. Not quite; if this were as helpful as *projecting ſhadows on the wall.*

P. It is at leaſt as helpful. The imagination is beſt informed from the eyes: however, as it is neceſſary you ſhould underſtand how this is in general, if you will come here at any of your leiſure hours, we will amuſe ourſelves a little with *drawing* and *cutting* figures. The thing will eaſily become plain that way, as well as by numbers.

M. I will not fail.——But pray do me the favour to inform me next, how far the ſun may be diſtant from us?

P. I have told you juſt now, Matho, that we find the diſtance of the moon, by the help of the ſemidiameter of the earth, the length of which we know: but the diſtance of the ſun is ſo vaſtly great, that the earth's ſemidiameter hardly bears any proportion to it. For thoſe, who tell us there is a certain proportion between them, are far from being agreed what it is. Some ſay the earth's ſemidiameter is about the 15000th part of the ſun's diſtance; others, that it is only a 20000th part of it: but others affirm, that it is conſiderably leſs than the 30000th part of it.

M. This indeed is equal to ſaying nothing.

P. According to this laſt opinion, the diſtance of the moon from the earth is not the 500th part *of the ſun's* diſtance from it. *M.* Strange!

M. Strange! How prodigious muſt the ſun's velocity be then!

P. What velocity?

M. That whereby he makes a revolution round the earth in twenty-four hours. The moon, though ſo much nearer us, requires ſtill ſomewhat longer time.

P. Cynthia, you know, a delicate virgin, cannot be ſuppoſed to keep up with her brother Phœbus.

M. I do not want to hear the *poets*, but the *philoſophers*.

P. Or perhaps it is the law of theſe motions, that the moſt diſtant bodies ſhould perform their revolutions round the earth in the ſhorteſt time.

M. It is excuſable in me, Philon, to be hitherto ignorant of the laws of theſe motions; therefore pray inform me what prodigious force drives the ſun round the earth every day, though removed to ſuch an immenſe diſtance from it?

P. You might alſo aſk me, Matho, what force (yet more prodigious) drives round all the other cœleſtial bodies; the ſtars which are without number, and the ſtarry frame of heaven itſelf. Theſe are placed at a much greater diſtance than the ſun, and perform their courſe ſomewhat ſooner: ſo that, as I ſaid, the moſt diſtant, at this rate, muſt finiſh their diurnal revolution in the ſhorteſt time.

M. That is, indeed, what I ſhould have aſked: the difficulty, I ſee, is vaſtly increaſed!——Well, this only heightens my curioſity and deſire the more: unravel therefore theſe wonders, and tell me whence the mighty force proceeds, which thus whirls round the whole frame of nature in the ſpace of one day?

XXIII. *P.* I could eaſily ſhew you ſuch a trifle as this, if you would explain to me by what force this chamber we are in, and even the whole houſe itſelf, whirls round this little globe I have in my hand, with ſuch rapidity every moment.

M. Why do you put me off, Philon, in this joking way, which is nothing to the purpoſe? The chamber does not wheel round that little globe, but you twirl the globe about with your fingers, while the room and whole houſe remain immoveable.

P. If it be ſo here, Matho, I am afraid you will find it ſo in the other caſe: for conſider, this little ſpot you ſee here is our iſland of Great Britain; and let the *window* there repreſent the ſun. Now Britain being in this poſition, or directly oppoſite to the ſun, we have mid-day; but as the iſland moves thus to the *eaſt*, the ſun ſeems to decline towards the *weſt*; and afterwards to ſet beyond the mountains, as it loſes ſight of him. The motion thus continuing all night, when Britain hath got through the ſhadow of the earth, and begins to turn about again to *the rays* of the ſun in the *eaſt*, he ſeems to be riſing in that quarter, and gradually to mount up the ſky, as *this ſpot* turns toward him; till it is again directly oppoſed to him, and the diurnal revolution finiſhed.—— Now, Matho, is what paſſes in the heavens different from this repreſentation of the matter which I have given you?

M. Softly, Philon! the two caſes are quite different; I ſee plainly the heavens carried from *eaſt* to *weſt*, while the earth ſtands ſtill: but here, on the contrary, the chamber and window have no motion, only you turn this little ſphere in your hand.

P. Cer-

P. Certainly, Matho, you do not perceive the heavens to move more than the earth; nor the earth to reſt more than the heavens: only after ſome time you ſee that the part of the earth, where you are, hath changed its ſituation with reſpect to the heavenly bodies. Wherefore your *ſenſe* doth not ſhew you either the motion of the heavens, or the reſt of the earth, which you ſtand upon. And did not you yourſelf, at our firſt meeting, ſay, *You wondered how the ſun moves over ſo large a ſpace every day, and yet ſeems not to ſtir out of the place?*

M. To own the truth, I find now, I do not *ſee* the motion of the ſun or heavens, but *infer* from my having changed ſituation with reſpect to them, that they move, and the earth ſtands ſtill.

P. If this be all, would it not be as agreeable to reaſon to infer from this change of ſituation, between the parts of the earth and the heavenly bodies, that the earth moves, and the heavens ſtand ſtill?

M. I begin to be ſtaggered.

P. Where the informations of our ſenſes are doubtful, we ought to conſider the reaſons of things, and determine according to them, leaving the informations of ſenſe quite out of the caſe.

M. That is but reaſonable, if once we were certain that the informations of ſenſe were doubtful in this point.

P. We will therefore examine the point more narrowly.

XXIV. Wherefore let us ſuppoſe that the earth *really moves round* on its own axis from *weſt* to *eaſt*, and that in the ſame time in which the heavens ſeem to be carried round from *eaſt* to weſt:

weſt: and then tell me what changes would happen from this *real motion* of the earth, according to the information of your ſenſe?

M. I cannot indeed be poſitive.

P. Conſider if theſe are the changes which would happen. The parts of the heavens towards the *eaſt* would come in ſight one after another, while like parts on the *weſt* would go out of ſight in the ſame manner: or on the eaſt ſome parts of the heavens would always be riſing, and on the *weſt* others always be ſetting; the middle parts moving gradually to the ſame hand. And in four and twenty hours the whole heavens would thus ſeem to riſe and ſet. Are not theſe the appearances we ſhould obſerve on this ſuppoſition?

M. They are ſo in truth. For I perceive now from what is ſaid before, it is the ſame thing as if, the earth ſtanding ſtill, a man were carried with the like velocity from *weſt* to *eaſt*, who muſt ſee the heavens and ſtars thus to riſe up before, and ſink down behind him, as you ſhewed me when ſpeaking of the method of meaſuring the earth. I plainly ſee that the earth's carrying the man from *weſt* to *eaſt*, or the man's moving over the (immoveable) earth, with the ſame velocity, and to the ſame hand, could not alter the appearances of the heavenly bodies ſeeming to riſe as he advanced to the one ſide, and ſet as he retired from the other.

P. You will eaſily perceive, Matho, ſince the motion of the earth on its axis muſt be equable and ſmooth, without ſuccuſſion or jolts; and ſince we ſee ſuch a large portion of its ſurface round us, the parts of which are all relatively at reſt among themſelves, and with reſpect to us, who muſt be carried along with them: I ſay, you will eaſily

perceive

perceive from thence, that we could be ſenſible of its motion no otherwiſe, than by obſerving the horizon (as it is called) where the earth ſeems contiguous with other objects; for all the changes produced by its motion muſt appear there.

M. I apprehend perfectly what you ſay, and ſee the truth of it. A blind man could not be ſenſible of his being carried along in a coach, or any other way, unleſs it were by the ſuccuſſions or jolting; nor a man with his eyes open, unleſs he perceived himſelf to draw nearer to ſome objects, or leave others farther behind him: neither of which circumſtances can be in the motion of the whole earth.

P. Moreover, that the ſun or ſtars ſeem to riſe higher and higher above us, ought to create no prejudice in our minds againſt the earth's moving, and their ſtanding ſtill; for ſince *over our heads* is always *upward* to us, they will ſeem to riſe higher in the heavens as we are turned more toward them.

M. This is eaſily conceived; for while the ſun is higheſt to us at noon, he ſeems to be mounting up from the *eaſt* to thoſe that are *weſt* of us, and low ſunk in the *weſt* to thoſe who are *eaſt* of us.——

P. Well, are not the changes I named thoſe which would appear, if the earth moved, and the heavens ſtood ſtill?

M. They are.

P. Are they not the ſame too with the changes that really appear?

M. They are.

P. Could any one then on this ſuppoſition conclude that the heavens moved?

M. If he did, he would conclude very falſely.

P. But

P. But ſince the changes really happen now, which would happen from the motion of the earth, can a man fairly infer from them that the earth ſtands ſtill?

M. Since you have ſhewed me ſo convincingly that the changes, which I ſuppoſed would happen if the earth ſtood ſtill, are preciſely thoſe that muſt happen if it moves, I am ready to give up the queſtion.

P. Let us go a ſtep farther if you pleaſe, and ſuppoſe that the earth moved ſo ſwiftly round its axis, that our iſland would return to the ſun (by ſuppoſition immoveable) every quarter of an hour; in that caſe what motions do you think ſhould we perceive?

M. We could then no more perceive the motion of the earth than at preſent: but the ſun and ſtars would ſeem to roll over our heads with the ſwiftneſs of a bird flying: and the ſtars near the horizon (where the motion muſt be chiefly perceived) would appear to run along the tops of the hills with ſurprizing celerity. In which caſe indeed even our ſenſes would ſeem to inform us of the motion of the heavenly bodies.

P. But would they inform us truly?

M. Nay, their information then muſt be the greateſt fallacy.

P. Our ſenſes inform us, Matho, that the moon moves to the *north* with the ſame celerity that the clouds below her fly towards the *ſouth:* they inform us that the *trees*, *houſes*, and other objects on the ſhore, draw back from the ſhip in which we are, while ſhe goes out of the harbour.

M. Enough, Philon, I give up the point. I am ſatisfied our ſenſes can in no caſe prove to us

the

the motion of the heavens; and that we are to be determined by reaſon, and not the dubious appearances from ſenſe.

XXV. But what reaſon can be given why the earth ſhould move rather than the heavens?

P. The earth perhaps is rooted in ſome immoveable baſis.

M. I do not pretend that hinders it.

P. And what reaſon then, Matho, *can* be given, why *one ſingle body*, and that one of the ſmalleſt, ſhould not revolve on its own axis in the ſpace of twenty-four hours, rather than that all the world, infinitely larger in bulk, ſhould be carried round in the ſame time with inconceivable rapidity, as being placed at an immenſe diſtance from it: and all this to no other purpoſe than to bring about the *viciſſitude of light and darkneſs* to this one little body?

M. This really would be ſomething like ſuppoſing your chamber-window and the whole room to be carried round the little ſphere, rather than that the ſphere itſelf ſhould be turned to the light.

P. Let any perſon, Matho, who contends that the earth does not move, ſay, whether it receives any other benefit from this whirling round of the whole heavens, than the enjoying the viciſſitude of light and darkneſs every four and twenty hours?

M. I ſee no other advantage it can be ſaid to receive.

P. But if the ſun alone could procure it this advantage, by his revolving about it every day; to what purpoſe is it to bring in ſo many huge bodies to perform this effect, which do not contribute one jot towards it?

M. As this would be quite ſuperfluous in nature, ſo the ſuppoſition ſeems to be very unnatural.

P. Wherefore, ſince they cannot ſuppoſe ſuch a diurnal motion in the ſun alone, without ſuppoſing the whole univerſe to be at once carried round; it is certainly more reaſonable, in every reſpect, to acknowledge the rotation of the earth on its own axis, than to raiſe ſuch an infinity of motion through all nature to no end.

M. This is really ſo abſurd, that one cannot help conceiving an indignation to hear that it is contended for: and I ſhould think the opinion muſt have prevailed at firſt, becauſe men were ignorant how ſmall a body the earth was, and of what figure: for as a ſpherical figure is moſt proper for ſuch a rotation round an axis, ſo it ſeems deſigned for this motion.

P. And that it is more ſpherical or protuberant about the equator, and flat towards the poles (which I obſerved to you before) is owing to this diurnal rotation: but we muſt content ourſelves with barely mentioning this particular at preſent.

M. And yet I have ſome faint notion of what you ſay: for if we again imagine the whole terraqueous globe to be fluid, I plainly ſee it could not thus roll round on its own axis, without *riſing* or *ſwelling* a little towards the middle: and ſince the dry land follows the figure of the ocean, or fluid part of the globe, I can eaſily allow that the whole terraqueous globe muſt have ſuch a figure.

P. This is helping yourſelf to right conceptions of this matter, from a circumſtance I had forgot.

M. I fancy too I now ſee the reaſon of a particular, which you mentioned before; but left the explication of it till a more proper time.

P. Pray put me in mind of it.

M. You ſaid the weight of the large tracts of mountains on the ſeveral parts of the earth muſt balance each other. Now if the earth had ſuch a *bunch* on one ſide, without any thing to balance it on the other, the motion I conceive could not be ſmooth and equable, but *unequal* and *bobbling*. Unleſs our tops were rightly balanced and round, we could never get them to go ſmooth, or *ſpin*, as we call it.

P. Your diverſions, Matho, are frequently of uſe to us. If the earth had ſuch an excreſcence on one ſide, without any thing to poiſe it on the other, that would diſturb its *ſpinning* on an axis, and at laſt ſpoil the habitable globe. Take a ring with a ſmall ſtone in it, and give it a ſmart twirl on a ſmooth table, ſo that the ſtone may be about the equator or middle of the ring's motion, and you will find the ring will not whirl round with the ſtone in that poſition; but the ſtone will riſe up till it be in the pole of the ring's motion, and there it will keep. But if there were a like ſtone on the other ſide, they would both keep to the equator, becauſe of their equal *centrifugal force*, as it is called.

XXVI. *M.* You mentioned alſo another particular lately, when ſpeaking of the ſpherical figure of the heavenly bodies, which ſeems ſtill to ſhew us farther how natural it is that the earth ſhould have a diurnal revolution on its axis, and not the whole heavens with all the innumerable bodies in them.

P. Let me know what it was.

M. You ſaid *ſome of the cœleſtial bodies, and among theſe the ſun himſelf, are always* turning round, and

and ſhew us ſucceſſively all their different ſides; which, if it be ſo, why ſhould not the earth turn round likewiſe on its axis, rather than all the heavens keep ſuch an eternal whirling to ſave it the trouble?

P. It is very opportunely remembered, Matho; for Jupiter, the largeſt of the planets, and far ſurpaſſing the earth in magnitude, is obſerved to roll round on his axis in leſs than ten hours: Mars performs a revolution on his axis in the ſame time nearly as our earth; and Venus in about twenty three days, as has lately been diſcovered: though Saturn's great diſtance from us, and Mercury's being too near the ſun, has hitherto hindered the ſame obſervation from being made upon them. Now laying aſide all the other reaſons already mentioned, it is perfectly agreeable that the earth, which is itſelf one of the planets, ſhould have the ſame motion as the reſt of them have (as far as our obſervations can reach;) and that too a motion ſo neceſſary to the nature and condition of a planet. Nor is it leſs abſurd in us, the inhabitants of this globe, to contend that the whole heavens ſhould wheel round in twenty-four hours, to anſwer its neceſſities, rather than allow the globe itſelf to move; than it would be in the inhabitants of the planet Jupiter (if any ſuch there be) to maintain that the heavens muſt roll round that planet in ten hours, that all its ſides ſhould enjoy the light ſucceſſively, rather than grant that their habitation ſhould have ſuch a diurnal motion.

M. And yet they would have the ſame reaſon to contend for the one, as we have to contend for the other; ſince Jupiter's rolling round on his axis in ten hours would make the whole heavens appear

appear to them to turn round in that ſhort time, juſt as they ſeem to us to turn round in four and twenty hours: though it is plainly impoſſible that one and the ſame revolution ſhould be performed in twenty-four hours, and in leſs than half that time.

P. You run the parallel between the two ſuppoſitions very exactly, and might ſtill go farther: for to a ſpectator on the planet Mars, the revolution of all the cœleſtial bodies would ſeem to be performed in about twenty-four hours; and only in almoſt as many days to one carried round on Venus. In ſhort, if all the planets turn round on their axes in different times, the cœleſtial bodies, though unmoved, would ſeem, to ſpectators placed on theſe planets, to revolve in as many different times. Nay, if any great body rolled on its axis from eaſt to weſt, while others really turn from weſt to eaſt, the ſun and ſtars, to the different ſpectators, would appear to turn from weſt to eaſt, and the contrary way, at one and the ſame time.

XXVII. *M.* I am ſatisfied from this variety of caſes, that the ſenſes are bad judges of the *reality* of motion. But ſome things you ſaid juſt now raiſe my curioſity to a great degree.

P. What are they?

M. I would gladly know, in the firſt place, why the planets perform their revolutions on their axes in ſuch different times, without any reſpect, it ſeems, to their magnitudes; as alſo if it be yet diſcovered how much higher the earth is about its equator, than at the poles; and if Jupiter, which rolls round ſo much ſooner, hath his equator thus raiſed?

P. It will be proper, Matho, to delay the conſideration of *theſe niceties* for ſome time.

M. Let it be ſo then: but as you have made mention of ſeveral planets, which, as far as I can gather from your words, ſeem to be of the ſame nature with our earth, which you alſo called a planet; and as you ſpoke of the *diſtance* of Saturn, the *magnitude* of Jupiter, and the *nearneſs* of Mercury to the ſun, pray explain this matter more fully. As theſe things are quite new to me, I imagine they muſt be very entertaining; eſpecially, ſince you ſpoke as if it were not impoſſible that the planet Jupiter might have ſome inhabitants reſiding on him.

P. To ſatisfy you in ſome ſort, I ſhall ſhew you, in few words, the true conſtitution of what is called the *ſolar* or *planetary ſyſtem*, and give you a ſcheme of it, done by a careful and curious hand, which will make the thing more intelligible than words can do.

M. I am glad of that; for as you obſerved, *the imagination is beſt informed from the eyes.*——

P. In the center of the whole ſyſtem is the Sun himſelf, which, notwithſtanding the diminutive appearance he makes to us at this diſtance, is an *immenſe ocean* of heat and light. Next to the ſun is the planet Mercury, which performs a revolution round him in about three months time; for Mercury's motion is more ſwift than that of any other planet. As he never removes far from the dazzling light of the ſun, it is difficult to get a view of him; yet ſometimes he is ſeen as a dark ſpot on the ſun's diſk, as he paſſes betwixt him and us. Above Mercury is Venus, which makes a fine appearance in the heavens, ſeeming to dart a *ſtrong* and beautiful light. She finiſhes her

circuit about the ſun in two hundred and twenty-five days, or ſeven months and a half nearly. Next to Venus is our Earth, which together with the Moon, as an *attendant*, completes its courſe round the ſun in the ſpace of a year, in which time the moon revolves about it, as a center, between twelve and thirteen times. Above our earth is Mars, being the fourth in order from the ſun, and takes up near two years, or ſix hundred and eighty-ſeven days in moving round him: for the motion of the upper planets becomes always ſlower. At a great diſtance above Mars is Jupiter, the ſtatelieſt and moſt majeſtic of the planets. He hath four moons, not unlike *ours*, rolling about him, one without another; which, conſidering the ſhort duration of their revolutions, afford a delightful ſpectacle, and conſtant variety of appearances to a ſpectator there. This planet requires little leſs than twelve whole years to complete his period round the ſun. Laſt of all comes Saturn, and cloſes up the *planetary chorus*; for his exterior and ample orbit ſurrounds them all. As he is the remoteſt from the ſun, he encloſes the ſyſtem with ſtate and dignity, having a miraculous ſort of an *arch* or *ring* about him, in which he ſeems to hang pendulous; and without that arch are five moons, which attend him through his whole courſe, as the moon does our earth. The motion of this planet being the ſloweſt of all, before he can finiſh his tedious journey round the common center of the planets, it is twenty-nine years and near a half.——Theſe are the *ſeventeen bodies* that make up the ſolar ſyſtem; and as I ſaid this ſcheme will repreſent to you their order from the ſun, and the orbits, as well of the ſix *primary* planets, as of the ten moons, or *ſecondary*

planets, which are alſo called *ſatellites*. You have likewiſe marked on the ſame ſheet their *periodical times*, and the proportion of their diſtances from the ſun, with other particulars neceſſary to be known, which I would adviſe you to imprint on your memory; for every thing in this ſyſtem is *proportion* and *regularity*.

M. I ſhall endeavour to obey you. But theſe ſeventeen bodies are but a ſmall part of thoſe lights we obſerve in the heavens.

P. And but a very ſmall part of them too: for beyond the limits of our planetary world, and at an immenſe diſtance without the orbit of Saturn, are the *fixt ſtars*, which you ſee ſparkling, in a *winter evening*, with ſuch various ſplendor and magnitudes.

M. How pleaſant muſt the intelligent contemplation of theſe things be, when the bare hearing of them, and looking on this *diagram*, throws me into ſuch an extaſy of wonder and delight! ——But here again I muſt beg a reſpite of you for ſome days, till I digeſt a little in my mind theſe different particulars: leſt the *novelty* and *variety* ſhould make me either confound or quite loſe them.

P. You call the *renewing* of your toil *a reſpite* from it: but I willingly conſent to what I had deſigned to have aſked of you, if you had not prevented me.

THE

Third CONFERENCE.

Objections againſt the diurnal motion of the earth on its axis anſwered. The difference between abſolute and relative, true and apparent motion, familiarly explained. Of the magnitude of the ſun in reſpect to the earth. A reaſon why the ſun ſhould be ſo big. The arguments which ſhew the annual motion *of the earth. How that motion is known by the ſtars in the night time. That the great changes in nature, with reſpect to us, are owing to the diurnal and annual motions of the earth. How the viciſſitudes of the* ſeaſons, *and lengthening or ſhortening of the days and nights are cauſed by theſe two motions.*

XXVIII. *P.* I Am glad, Matho, to ſee you here again. How do you like the ſubjects we were upon in our laſt converſation?

M. Extremely well; for I think I enter into the reaſons of things pretty exactly, and have got by heart what only required memory.

P. Have you no remaining doubts concerning the diurnal motion of the earth on its axis?

M. I went away, you know, full of it; and am ſtill ſatisfied of the reality of that motion; but was not able to ſatisfy my companions, ſo as to bring them over to my ſide.

P. Why ſo?

M. They obſerved, if we throw a ſtone directly up, that it falls down juſt at our feet again. But if the earth whirled with ſuch rapidity from weſt to eaſt, the part, from which the ſtone was thrown up, muſt be carried a conſiderable way eaſtward, while the ſtone is in the air; ſo that it would fall to the weſt of the part from whence it was caſt up.

P. This is a very common prejudice, and pardonable in young people.

M. From this I raiſed ſome other difficulties to myſelf; as why the birds, when they fly, do not ſeem ſtill to be carried weſtward, while the earth moves ſo ſwiftly below them the contrary way. I have alſo obſerved, if I run with ſome violence, a breeze always meets me in the face, though there be no air ſtirring: whence I think there ought conſtantly to be a ſtrong wind from the eaſt, while the place we are in is carried from the weſt with ſuch velocity. If theſe difficulties could be eaſily removed, I ſhould be able, I think, to deal with my adverſaries.

P. Before they can be removed, you muſt underſtand a certain *maxim* in philoſophy, which is, *That a body placed any where, partakes of the motion of its place.*

M. Explain the maxim by an example.

P. If a ſhip be under ſail, and move ſmoothly along, the ſeveral motions of people below deck, or walking above, are performed in the ſame manner, as if the ſhip ſtood ſtill.

M. This I underſtand tolerably well; for though I was never at ſea, yet I have been in a ſhip while ſhe was going out of the harbour: but ſtill it does not ſatisfy me. I think it ſhews rather, that a body, which is contained in a thing, partakes

takes of the motion of that thing which contains it; be it ſhip, veſſel, or whatever elſe we pleaſe to ſuppoſe. How can the earth be ſaid to contain the *ſtone*, or *bird*, which is in the air? Or how can it be the *place* of theſe, when quite ſeparated from it?

P. You are hard to pleaſe, I find: but ſince this will not do, let us come to another inſtance. ——Suppoſitions, you know, coſt nothing; and provided they be not impoſſible, we may make them at pleaſure, in order to reaſon from them.

M. This I have obſerved from ſome ſuppoſitions you have made before.

XXIX. *P.* Suppoſe then there was a *plain*, like the floor of this chamber, moving ſmoothly along the ground, which you may alſo ſuppoſe to be level like a bowling-green; and we may imagine this plain to be extended to any breadth we have a mind. Let us likewiſe ſuppoſe, that a *frog* is carried along upon it.

M. I long to ſee the event of this ſuppoſition.

P. You will eaſily allow that the frog would leap and perform all its motions on this plain, in the ſame manner as if it had no motion.

M. Certainly; for it is the ſame thing as if ſhe were on the deck of a ſhip.

P. I ſhall go on then with the ſeveral caſes of my ſuppoſition, without expecting your aſſent, or diſſent, until I have done; and then you may give me your judgment.

M. We ſhall indeed ſave words by that means.

P. If the utmoſt extent to which the *animal* could leap was two feet, it could leap ſo far on the plain, whether that moved or ſtood ſtill. Imagine now the creature to jump two feet in a direction preciſely oppoſite to the direction of the mov-

ing plain, and that the plain moved juſt two feet in the time of the frog's leap, or while it was in the air. Here it is evident that the frog, taking its leap the contrary way to the motion of the plain, would reach two feet from the place it ſtood on: but by ſuppoſition, the plain moves juſt as much the contrary way. If therefore there were a hole in the plain juſt where the frog was to light, it would fall on the ſame part of the ground, over which it ſtood when it began to jump. This is the firſt caſe. Suppoſe now it jumps the other way, or in the ſame direction with the motion of the plain; it will then likewiſe reach two feet from the place it ſtood on, and the plain moves two feet the ſame way in the ſame time: ſo that if there was a hole in the plain where the creature was to light, it would fall on the ground four feet from the place above which it began its leap. In the firſt caſe, the *yielding*, or contrary motion of the plain, when the animal puſhed it to begin its leap, has ſuch an effect, that it carries the creature as much backward, as its own effort carries it forward: ſo that with reſpect to the ground below the plain, it neither moves backward nor forward; nor has its jump any other effect, than if it had leapt perpendicularly up, and fallen down again. And any one, not carried along, but obſerving the motion of the animal, without attending to that of the plain, would imagine that it roſe, and fell back, perpendicularly. In the ſecond caſe, the conſpiring motion of the plain carries it twice as much forward, with reſpect to the ground below, as its own ſingle effort could do.

M. Pray let me ſpeak a word.

P. That is againſt conditions.

M. One

M. One ſingle word, to tell you that I conceive this, and have obſerved, when ſome of us have been in a boat, and rowing againſt the ſtream with all our might, all we could do was only not to be carried down, but keep oppoſite to the ſame part of the bank of the river: but if we rowed down with equal force, we made way at a great rate. I have done.

P. Let us ſuppoſe, in the third place, that the frog jumps to a ſide with reſpect to the direction of the plain's motion, or two feet ſtraight outward; and imagine that on the ground below, from the part over which the creature makes its leap, there is a *ſquare* deſcribed for two feet outward, to the ſame ſide. The animal will leap ſtraight outward, to a point two feet diſtant; and that point is, in the interim, carried two feet forward, by the motion of the plain: ſo that if there were a hole at that point, it would light juſt in the oppoſite angle of the ſquare on the ground; and muſt therefore, while it jumps ſtraight outward, with reſpect to the plain, have always been above the diameter, or *diagonal* of the ſquare, with reſpect to the ground.

M. I beg you would hear me but one word again.

P. Then you may go on by yourſelf, Matho.

M. You will own it is worth your while to hear me. I can ſhew this by a piece of paper moving along another piece of paper; and that by drawing a line ſideways on the upper paper, and a ſquare below that on the under paper, as you ſuppoſed to be done on the ground, a creature, that moved from end to end of the line, ſhould move from angle to angle of the ſquare below. Do I not rightly apprehend it?

P. You do indeed. In the laſt place then, let us imagine that the creature jumps perpendicularly up, and that the time or duration of the leap is the ſame as before. It muſt fall down again on the ſame part from which it roſe, as well when the plain moves, as when it ſtands ſtill: for in the former caſes, its diſtances on the plain were the ſame, as if that had been without any motion: but this place it alights on now is carried on two feet, while the animal is in the air: and if there were a hole there, it would fall on the ground two feet beyond the place from above which it roſe. With reſpect to the plain, therefore, its motion is a perpendicular aſcent and deſcent; but with reſpect to the ground, it is ſuch a *curve*, as a frog commonly deſcribes, when it leaps upon the ground. Now, Matho, you are at liberty to ſpeak.——

XXX. *M.* I conceive this well enough; but am ſtudying to find out ſome way to repreſent the two different appearances of this ſingle motion. ——Suppoſe the plain moving on the ſame level with the top of a wall, and that you were on the other ſide, not ſeeing the plain moving along, but only the animal as it mounts up and comes down; though it comes down on the ſame part of the plain from which it roſe, you would think that it jumpt along the top of the wall.

P. You are right: the ſame motion muſt make a different appearance to one carried along with the plain, and to another ſtanding on the ground. Imagine now, there was no more a plain in all theſe caſes, but only that the part the animal ſtands on hath the ſame motion the plain was ſuppoſed to have; and the diſtances on the ground,

and

and the places of alighting, will be the ſame as before. The creature would either fall on the place immediately below where it ſtood; four feet onward; move above the diagonal of a ſquare; or fall two feet beyond; as in the ſeveral ſuppoſitions above. For the exiſtence of the plain hath no effect on its motion while it is in the air.

M. I am entirely ſatisfied about every particular of this; nevertheleſs, when you ſum up all in ſo few words, the thing ſeems ſcarce credible. I am ſure I could not have underſtood it, without the ſeveral ſuppoſitions you have made.

P. Hence you will perceive what is to be ſaid to the objection of a ſtone thrown perpendicularly upward.

M. I perceive, though it riſes and falls perpendicularly, with relation to the ground, yet abſolutely ſpeaking, it is carried along with the earth all the time, or partakes of its motion to the eaſt; juſt as the animal was carried along with the plain, becauſe it took its riſe from that when in motion.

P. You will likewiſe eaſily conceive, if the ſtone be thrown eaſtward or weſtward (that is, *with*, or *againſt* the earth's motion) it muſt ſtill be carried eaſt; unleſs we ſuppoſe the force, with which the ſtone is projected, ſuch, that the projection ſhould carry it as much weſt, as the motion of the earth carried it eaſt. Then abſolutely ſpeaking, the ſtone would neither move eaſt nor weſt. And if the ſtone were projected with ſtill greater force, it ſhould really move weſtward.

M. I underſtand; for if, in the firſt caſe above, the jump of the frog had been three feet, in the time that the plain moved two, the creature ſhould have fallen on the ground a foot beyond the place above which it made the leap. I underſtand like-

wiſe, if the ſtone is thrown neither with, nor againſt the earth's motion, but to a ſide, that is, ſouthward or northward, that in the time it is carried ſouth or north, with reſpect to the earth, it will alſo, by partaking of the earth's motion, be carried eaſtward; ſo that abſolutely ſpeaking, it will be carried ſouth-eaſt, or north-eaſt, as where the frog moved above the diagonal of a ſquare.

P. Nor will you find it difficult to conceive how any other *projectile*, a *bomb*, or *cannon-ball*, for inſtance, muſt partake of the motion of the earth, in whatever direction it is projected.

M. I perceive what may be ſaid in all theſe caſes. The *ball* or *bomb*, by partaking of the earth's motion, is thrown to the ſame diſtance, and hits the mark in the ſame manner, as if the earth did not move: ſo that ſuch *inſtances* as theſe can be no longer any objection to the earth's motion.

P. As to your next difficulty then.

M. There is ſomething that occurs, from what we have been ſaying juſt now, which I would willingly firſt ſpeak to.

P. What is it?

XXXI. *M.* I am conſidering with myſelf, how really diſtinct *abſolute* and *relative* motions are; and yet how difficult it is ſometimes to diſtinguiſh the one from the other.

P. Thoſe who confound theſe two motions, Matho, make their *ſenſe*, and not *reaſon*, judge of the reality of motion: but let me know, by an example, where your difficulty lies.

M. In the inſtance you gave juſt now of *a body projected to the weſt, with the ſame celerity the earth is carried to the eaſt*, we ſhould fancy it to move very ſwiftly to the *weſt*, and be ignorant, in the mean

mean while, that we ourselves were only moving with that celerity to the *east*.

P. This is no more than what you yourself observed before, when you said you were satisfied from a variety of instances, *That the senses are bad judges of the reality of motion.*

M. This I said, and am still convinced of it; and that we are to judge of real motion by reason, and not the dubious informations of sense. But I would know the true difference betwen real and apparent motion, by the help of which difference reason may distinguish between them.

P. The difference in few words is this, a body may appear to move without any force impressed upon it; that is, the distance between it and other bodies may be changed, without its receiving any impulse to make it change its place: but a force must necessarily be impressed to put a body in real motion, or to stop it again when moving.

M. Therefore wherever there is a relative motion, there must be real motion in some of the bodies?

P. Certainly; for if all the bodies in the universe were at rest, the distance between any of them could not be changed, unless a force were impressed on some of them at least.

M. And on the contrary, wherever there is real motion, there must be a relative motion or change of distance.

P. That doth by no means follow.

M. Pray shew me how it can be otherwise: for I think they must necessarily accompany each other.

P. Imagine there was but one body in nature, as our earth, and that no force was impressed

preſſed upon it; would it move, do you think, in that caſe?

M. It could not without ſome external force to put it in motion.

P. Imagine then that ſome *mighty hand* impreſſed a force upon it; and tell me what the effect of that force would be?

M. It would certainly be moved, whether any other body exiſted or not, the diſtance between which and it might be changed: for it is nonſenſe to ſay that a *force impreſſed and no force impreſſed*, ſhould both have the ſame effect.

P. You are right Matho: real motion doth not depend on change of diſtance, or the exiſtence of another body; though relative motion doth. For take it thus: imagine that two bodies only were created in nature, and a force impreſſed on one of them ſufficient to move it with a certain degree of celerity; you know it would move on without end in the immenſe ſpace, and with the ſame celerity ſtill.

M. You have already ſatisfied me of that.

P. Suppoſe then, after any time, that the body, on which no force was impreſſed, were annihilated, or removed out of exiſtence, by the ſame mighty power that created it; and tell me then, would the taking away of this body deſtroy the motion of the other?

M. No more than taking my ball off the *billiard-table* would hinder my companions from moving upon it.

P. Or ſuppoſe the body to be reproduced again; would the *firſt body* begin to move anew? Or would it move, or not move, according to the exiſtence or non-exiſtence of the other?

M. I am convinced of the double abſurdity; either

either that a body ſhould begin to move without a force impreſſed, or ceaſe to move without an obſtacle. This indeed is extremely pleaſant and intelligible.

P. Suppoſe again that only our earth and moon exiſted, and that the moon rolled about the immoveable earth at the ſame diſtance as at preſent. Here is both real and apparent motion, becauſe the moon is ſucceſſively oppoſite to the different ſides of the earth: but if we ſuppoſe the earth ſo to be turned round on its axis, as to keep the ſame ſide always expoſed to the moon, this will take away the relative motion: yet it would be fooliſh to maintain, that giving a motion to the earth on its axis took away the motion of another body.

M. It would be a new kind of abſurdity to affirm that, if both of them moved, neither of them could move.

P. Suppoſe again, that only two bodies exiſted in nature, and that both of them were put in motion with the ſame celerity, and in the ſame or parallel directions, and there will be real motion in both theſe without change of diſtance, or relative motion. The ſame alſo might be ſhewn of any number, or ſyſtem of bodies, if they were all urged in parallel directions, and with equal celerity.

M. This is all mighty clear.

XXXII. Now to my other objection concerning *birds* while ſuſpended in the air, which ſeems, I think, more difficult than the former.

P. On what are they ſuſpended?

M. They ſupport themſelves in the air, and fly through it by the motion of their wings, with which

which they ſtrike againſt the air: for if you move a ſingle feather ſwiftly, you will find the air make a conſiderable reſiſtance to it, as I have often tried. But my difficulty is not concerning their flight, but how they partake of the motion of the earth, and are carried round with it, though raiſed above, and quite ſeparated from it.

P. Well, it is eaſy to conceive that birds partake of the motion of the earth, even while they are in the air; as much as the frog did above the moving plain.

M. I ſhould allow that it might be ſo, if the flight of a bird was ſuch a motion as the leap of a frog; but it reſembles more, I think, the ſwimming of a fiſh: for after they take their *riſe* from the ground, they move faſt or ſlow, as they have a mind. And I have often obſerved a *kite* ſeem to ſtand ſtill a conſiderable time, without moving his wings at all.

P. Tell me, Matho, how are the fiſhes of the ſea carried round by the motion of the earth?

M. They are carried round in the water of the ſea, which is carried round by the motion of the earth.

P. How comes the water of the ſea to be carried round by the motion of the ſolid part of the earth? For if you take a *ſhallow veſſel*, not full of water, and move it to one ſide with no great velocity, the water will flow over the brim of the veſſel the contrary way. Whence, as the earth began to whirl ſwiftly eaſtward, the water of the ocean ſhould not have taken the motion, but have flowed weſtward, till it had been ſpread all around the whole ſurface of the globe.

M. I ſuppoſe, when the earth firſt received its diurnal motion, the force which produced *that* motion

motion was impreſſed as well on the fluid, as on the ſolid part of the globe; ſo that there could be no hazard of the ſea's overwhelming the dry land.

P. You are certainly right; it was as eaſy to impreſs the motion on the one part as the other: and without that the effect could not have been completed. Beſides, a dreadful commotion and uproar muſt have enſued on the face of the earth, whilſt the waters daſhed with inconceivable fury againſt the ſolid prominencies and ſides of mountains. But if we were willing to ſuppoſe all this tempeſt, the event muſt at laſt have been the ſame as on your ſuppoſition.

M. That I do not underſtand; pray ſhew me how it might have been?

P. It is not indeed to our preſent purpoſe; but as it may give you fuller notions of theſe things, I ſhall endeavour to obey you. Though the water of the ſea muſt at firſt have been put into a terrible commotion, and ſpread round the face of the globe, it would gradually have taken the earth's motion, and at laſt been carried round with equal celerity. And being then relatively at reſt, it would have ſought the lower parts, and formed the ocean as at preſent.

M. Pray explain the caſe more particularly: this gives me but a confuſed notion.

P. You know in the preſent ſtate of things, the ſea, rivers, brooks, &c. partake of the earth's rotation on its axis.

M. They do.

P. And moving with the ſame celerity, they are relatively at reſt with reſpect to the dry land, or ſolid part of the globe.

M. The ſea, or a lake, or pool, is as much at reſt

reſt with reſpect to its bottom, as a ſtone with reſpect to the ground on which it lies.

P. When the water therefore moves with the ſame celerity as the earth on which it is, that doth not hinder it to run down in rills, brooks and rivers, wherever it finds a deſcent.

M. It doth not indeed; for being relatively at reſt with reſpect to the ground, it runs down the ſame way on any declivity, as if the ground were without all motion.

P. Though the motion on its axis then had only been at firſt impreſſed on the ſolid part of the earth, ſo that on the firſt commencement of the diurnal rotation, the fluid part would have ſpread round the ſurface of the globe; yet in time it muſt have had the motion impreſt upon it, and at laſt have been carried round with the ſame celerity as the ſolid part.

M. It muſt indeed; for we cannot ſuppoſe it to have kept ſtill equally ſpread, without ſuppoſing it to be carried round with the ſame celerity: and it could not gather into heights, becauſe of its gravity.

P. Therefore the water on the globe coming at laſt to have the whole celerity of the earth impreſt upon itſelf, or being relatively at reſt with reſpect to the earth, muſt have ſought to the lower parts, and formed the ocean according to the hollows it found.

M. Now I ſee plainly that the event muſt have been the ſame at laſt in either caſe. But might we not likewiſe ſuppoſe, that the diurnal rotation was impreſt by degrees, to prevent ſuch diſorders?

P. We mortals are forced to proceed thus gradually in moſt things; becauſe we have neither power nor ſkill to do otherwiſe, but there is no parity in

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the two cases. This supposition however might be made, provided it be not understood as a mark of impotence in the cause.

XXXIII. *M.* Well, all this is extremely pleasant, and by it, I think, I perceive what may be said in the case of the birds being carried round with the earth, and partaking of its motion.

P. How then could you satisfy yourself as to that point?

M. The air must partake of the same motion with the earth; so that birds fly up and down in it, as if the earth, or it, had no such rotation.

P. So far you are right: and how came the air by this motion?

M. I imagine the same motion must have been at first impressed on it, as on the *earth* or *sea*: for the earth could not soon have impressed a motion on such a fluid, so as to carry it about with equal celerity. And all the intermediate time, it must, by not moving along with the earth, have raised dreadful *tempests*, both on the face of the waters and dry land.

P. A motion of the air, Matho, much less rapid than this would be, raises storms which beat down houses, tear the trees up by the roots, and work the greatest desolation both by sea and land. So that if we add the disorders of both *elements* together (the *sea* and *air*) they are perfectly inconceivable: but their rage we find is bridled down, and our globe rendered habitable.

M. It is indeed amazing that our bodies should be constantly hurried along with such prodigious impetuosity, amidst such furious elements, and irresistible motions, and yet that we should be as little incommoded by these, and even as insensible

ble of them, as if nothing ſtirred in nature! So little indeed, that men deny they are! The liquor in the cup is not ſhaken, the *infant* that has but juſt ſtrength to ſtand upright is not moleſted, and every thing is as ſtable and firm as if our earth reſted on ſome eternal foundation!

P. The reflection is pertinent. If theſe elements were not ſometimes allowed to break looſe, we ſhould be ignorant how powerfully our ſafety was wrought.

M. From all this I now perceive that my laſt objection to the earth's motion was entirely groundleſs: ſince the air is carried round with the ſame velocity as the earth, there cannot be a conſtant wind from the *eaſt* (as I fancied) ſweeping over the plains of the ocean, and bearing againſt the ſides of the mountains.

P. There could not, ſince the whole maſs of air, or *atmoſphere* (as it is called) is carried with equal rapidity the ſame way.

M. From hence I perceive, if a body were ſuſpended above the earth, ſo as not to partake of its motion, there would be a *furious guſt* againſt the weſtern ſide of it, while the air ruſhed violently by it to the *eaſt*.

P. Such body would rather be carried along with the impetuous motion of the atmoſphere; if not raiſed above the height of it.

M. You have ſaid that the moon is carried round our earth: pray is ſhe thus carried round by the force of the revolving atmoſphere?

P. Nothing like it, Matho: ſhe is carried round by quite another law of motion, nor does the atmoſphere reach ſo high.

M. How high doth it reach above the ſurface of the earth?

P. All

P. All *appearances* in the atmoſphere ſhew, that it doth not riſe one ſemidiameter of the earth above our heads; and the moon, you know, is ſixty ſemidiameters from us. The true limits of it, indeed, are not certainly known: the common conjecture is, that it doth not extend to above forty-five or fifty miles; though poſſibly a farther conſideration of the *ſtreaming lights*, which appear ſo frequently in the air of late years, may ſhew that it riſes conſiderably higher.

M. What force then carries the moon round the earth, twelve or thirteen times a year? For that is a point I want chiefly to be ſatisfied about.

P. Are not all the other ſecondary planets, or moons, thus carried about their *primaries*; and the primary planets themſelves thus carried round the ſun, the common center of the ſyſtem?

M. They are; and that makes the ſolution of the queſtion of greater importance.

P. To tell you this at preſent would do you no manner of ſervice; it would be like ſpeaking to you in an unknown language.

M. But if I come to it in a proper time, it will relieve me of a pain, as meat does of hunger.

P. You are right.

M. Well, I deſiſt. But this brings to my mind one ſmall difficulty more, and then I have done with my objections.

P. What is it?

M. It is with reſpect to our *upward* and *downward*. You allowed, and taught me, that *upward* and *downward* regarded only the centers of particular bodies, as our earth, or the ſun: and yet in ſpeaking of the order of the planets from the ſun, you ſaid Venus was above Mercury, Mars above our Earth, and Jupiter above Mars;

Mars; by which I underſtand, you reckon them all upward from the ſun. This perplexes me.

P. The conſideration of this affair muſt likewiſe be put off till another time.

XXXIV. However, from this I perceive you have the order of the ſolar ſyſtem in your head.

M. I told you I have every thing by heart that only requires memory. I can ſet up the whole ſcheme in my imagination at any time; but find it difficult to abſtract from the diagram on the paper, and apply theſe motions to the great bodies themſelves in the heavens. Yet ſometimes, when without doors, I endeavour to ſuppoſe that I am carried round the ſun with the earth; having Mercury and Venus on the inner ſide, or between me and the ſun, with Mars, Jupiter, and Saturn, on the other ſide.

P. That is not a bare ſuppoſition, Matho, but according to the reality of things. You take the right method in making yourſelf familiar with the heavens themſelves: they ſuggeſt quite other notions, than ſchemes within doors can do; and a little practice will make the thing eaſy to you.

M. But while I am thus employed, many things want explication; and I have not you at hand.

P. You will ſoon require a more ſkilfull guide: but in the mean time I ſhall convince you, rather of my want of ability than inclination to ſerve you; and in this view only you may propoſe your difficulties.

M. In the firſt place, I would know what may be the true magnitude of the ſun; becauſe I obſerved in your deſcription of the ſolar ſyſtem, you *called him a vaſt ocean of heat and light.*

P. I.

P. I have told you already, Matho, that the diſtance of the ſun from the earth is ſo great, that any method of meaſuring, hitherto contrived, cannot aſcertain it; though ſome of theſe methods are extremely ſubtle and ingenious: and without knowing the diſtance of the ſun, we cannot be certain of his true magnitude.

M. I underſtand. They, who make his diſtance from us to be 30000 ſemidiameters of the earth, muſt ſuppoſe him larger; and they who make it leſs, muſt ſuppoſe him ſmaller; that he may ſtill make the ſame appearance to the eye.

P. You are right. Now we ſhall leſs err in making him too large, if we ſuppoſe his diſtance to be only moderately great: and if we imagine *that* to be about 20000 ſemidiameters of the earth, his breadth, or diameter, will be ſome more than ninety times as great as the earth's. And ſince the diſtance of the moon from the earth is only ſixty ſemidiameters of the earth, if the ſun were placed where the earth is, his body would fill the whole orbit of the moon, and reach near 120000 miles above it.

M. Prodigious! It is not without reaſon that you called him *a vaſt ocean of heat and light.*

XXXV. *P.* You will form a better notion of the largeneſs of the ſun's body, from this coarſe plain repreſentation of it, than by expreſſing the proportion between it and our earth in numbers only. But this ſcheme will ſhew to your eye how large he is with reſpect to the other planets, according to the opinion of the *celebrated Monſieur Huygens*, who makes the ſun's ſemidiameter a hundred and eleven times longer than the earth's.

M. Pray let me conſider it.——What a diffe-

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rent appearance is this! The ſun here indeed makes a grand and noble figure, in compariſon of the planets.——Alas! what a ſmall thing is our earth! How is it ſhrunk up!

P. Yet this is that *mighty point*, about which the ſun, and all the heavens too, ſhould revolve every day.

M. Here is Saturn I ſee encompaſſed with the *miraculous arch* you ſpoke of. How much more juſtly might this planet, or Jupiter there, which is indeed by far the greateſt of the planets, challenge the pre-eminence of having the heavens to roll about them? What a difference there is between the reality of things and the appearance they make!

P. That reflection, Matho, is equally applicable to moſt things we know.

M. I no longer wonder that the ſun ſhould ſtill appear equally big over the whole face of the earth; for this is only to appear equally big over the whole ſurface of a point. Nor is the reaſon hard, I think, to be found out, why he ſhould be ſuch a vaſt body.

P. What reaſon, think you, can be aſſigned for it?

M. It is, I ſuppoſe, becauſe the *heat* and *light* of the ſun were to be diffuſed through the whole ſyſtem, as far as Saturn himſelf, whoſe diſtance from the ſun, as I underſtand from the former diagram, is near ten times greater than the diſtance of the earth from him.

P. You are perfectly right, this is one reaſon: but upon another account alſo, a body containing a prodigious maſs of matter was to be placed in the center of the ſyſtem.

M. Pray tell me on what other account?

P. It would not give you half the pleasure, nor do you half the service, to have another tell it you, that it would do to find it out yourself; which I foresee you will easily do hereafter.

M. I shall be directed by you.

XXXVI. *P.* In the mean time it is proper to acquaint you, that some philosophers place the earth, and not the sun, in the center of our system.

M. And how do they dispose of the sun in that case?

P. In the fourth place from the earth, having put in the Moon, Mercury, and Venus, between him and the earth; about which they say he revolves among the rest of the planets in the space of one year.

M. That is, having supposed the earth immoveable in the center, they ascribe its motion to the sun.

P. It is so: and I would know your thoughts of this disposition of the system.

M. Truly I think it is not quite so proper, that the noblest body of the system should revolve about one of the least bodies in it; and (which seems worse) that the *fountain of heat and light* to the whole system (for such I think we may call the sun) should leave the center, the most proper place for dispensing these equally, and go here and there, to chear one part of it, while the other parts are left languishing and uncomfortable till his return.

P. It would seem so to an unprejudiced person.

M. Besides, Philon, after what you have shewed me concerning the diurnal motion of the earth, which the sun and whole heavens were brought in to supply, I would be cautious in

aſcribing the earth's motion to the ſun in any caſe: for it looks ſuſpicious, as if this were only from miſtaking *apparent* for *true motion*.

P. That miſtake is indeed the foundation of this whole *hypotheſis*. But there is an eaſy way of diſcerning how falſe the hypotheſis is; for if the Sun, Venus, and Mercury, finiſhed their revolutions about the earth in ſuch different times, it muſt of neceſſity happen, that, while the Sun is on one ſide of the earth in the center, Venus or Mercury muſt be on the oppoſite ſide; as now the earth and either of theſe planets are frequently on oppoſite ſides of the ſun. But this never happens, nor can happen, ſince the ſun is in the center.

M. I think I underſtand the force of this argument, by the help of my ſcheme here: for ſince the orbit of the earth is exterior to that of Venus, or Mercury, they can never get to the ſide of the earth, oppoſite to the ſun. But if the earth were placed in the center, what happens to the ſun now would happen to the earth then.

P. You are maſter of the argument; but will ſee the irreconcilable difference better, by conſidering likewiſe this other ſcheme, which repreſents the ſyſtem of the world, according to the opinion *of theſe* philoſophers. It is called the *Ptolemaic*, as the former is called the *Copernican* or *Pythagorean ſyſtem*.——

M. I ſee here indeed their orbits in the order you mentioned; and by comparing the two ſyſtems together, the force of this argument appears very obvious.

P. There are beſides, Matho, other appearances in the heavens, which can never be naturally accounted for, if we place the earth in the center of the ſyſtem. For the other planets

ſeem

ſeem to us, ſometimes to *ſtand ſtill*, and ſometimes to *move backward*, inſtead of going forward, which is an appearance they could not make to us, if we were in the center of their motions.

M. I perceive, by conſidering this laſt ſcheme, that the earth being in the middle, all the other planets muſt appear to it to move the ſame way, ſome faſter, ſome ſlower; and never to move backward: but I do not ſo well conceive, in the preſent caſe, how any of them ſhould ſeem to go backward, while they really move forward.

P. You know the planets nearer the ſun perform their revolutions ſooner, on a double account, both as their motions are ſwifter, and their orbits leſs.

M. This you mentioned before.

P. The interior or lower planets then muſt ſeem, by their ſwifter revolution, to caſt the exterior planets behind them, or backward among the fixt ſtars.

M. I perceive it now, by looking to the firſt ſcheme: and thus Mars, Jupiter, and Saturn, muſt ſeem to us to move back a little among the fixt ſtars, as our earth paſſes betwixt the ſun and them with a quicker motion.

P. You have it exactly. A ſpectator in the higher planets likewiſe muſt think that the *interior* or lower planets go backward, or move contrary to the order of the ſigns, as they paſs more ſwiftly between the ſun and him.

M. This I apprehend from the former caſe: if Venus paſt between us and the ſun, while Mercury moved on the other ſide of him, though both proceeded the ſame way, or followed each other, yet they would ſeem to meet and croſs:

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whence Venus muſt appear to go backward, or contrary to the other. But is this obſervation eaſy to be made?

P. So eaſy, that you yourſelf may obſerve it in Saturn and Jupiter every year; and in Mars and Venus once in two years.

M. I am glad of that, methinks: for it ſhews, I take it, both the Copernican order of the ſolar ſyſtem, and the motion of the earth round the ſun, to a demonſtration.

P. But there is ſtill a *more noble argument*, Matho, which I would chiefly recommend to you, that you may purſue it, when more advanced in theſe matters; becauſe it illuſtrates and confirms the order and motions of the planets round the ſun, in a manner altogether particular.

M. Pray inform me what it is.

P. The *times* of the revolutions of the planets round the ſun, and their *diſtances* from him, are ſo connected by a certain proportion, which flows from a natural neceſſity, that one may venture to ſay, it is either ignorance, or determined obſtinacy, that makes men place the earth in the center of the ſyſtem, ſince ſuch a diſpoſition would ruin the moſt beautiful proportion, and ſtruggles (unſucceſsfully) againſt the ſtrongeſt neceſſity.

M. I beſeech you tell me what that proportion is, that I may at leaſt get the words by heart.

P. It is this, *The ſquares of the periodical times of the planets round the ſun are always as the cubes of their diſtances from him.*

M. I ſhall imagine that this ſentence contains ſome notable truth, and as ſuch cheriſh it in my memory.

XXXVII. But what is the reaſon why theſe philoſophers aſcribe to the ſun, not only a diurnal, but alſo an annual motion round the earth?

P. Juſt what you ſurmiſed lately; a miſtaking the *apparent* for the *true motion:* for while the earth is carried round the ſun, the ſun ſeems to move the contrary way. This appearance they took to be real motion in him: as if any one ſhould fancy a *diſtant tower* to move the contrary way to that which he himſelf was going, becauſe it ſucceſſively intercepted the view of more remote objects, in a contrary order.

M. And yet, at this rate, the ſun, beheld from different planets (Jupiter and our earth, for inſtance) would appear to move two contrary ways at once, as the planets themſelves were carried to oppoſite ſides; which is abſolutely impoſſible.

P. And not only two contrary ways at once, Matho, but (as was obſerved, with reſpect to the diurnal motion) he would ſeem to be carried round the heavens in very different times. For a ſpectator in any of the planets would fancy *that planet* immoveable, and impute both its motion and periodical time to the ſun. Thus, to a ſpectator in Mercury, he ſhould appear to be carried round in three months; and to another in Saturn, ſcarcely in thirty years.

M. Nothing ſolid can be eſtabliſhed on an appearance of ſuch an ambiguous, and equivocal nature as this. But pray let me know how I may obſerve this annual motion of the earth; for we are not ſenſible of its moving thus.

P. You have not yet had time to obſerve the retrogradation of the planets, which is one good way of being ſatisfied of the reality of the earth's

motion; as you yourſelf obſerved but a few minutes ago.

M. Pardon me; I did not reflect on that: but is there no other way to know it?

P. You know you cannot perceive the motion of the earth with your eyes.

M. That is true: we cannot thus perceive even its diurnal rotation; but infer it from the changes it produces round us.

P. It is the ſame here; you can only know the earth's annual motion from the changes which that produces.

M. By what changes ſhall I know it?

P. By what changes do you know one day from another?

M. It is ſuperfluous to aſk that queſtion.

P. By what changes then do you know the following from the former *year?*

M. Every year has its own parts, as much as the days have theirs.

P. Right: now as the diurnal motion of the earth on its axis makes *morning*, *evening*, *noon*, and *night*; ſo its annual revolution round the ſun divides the year into *ſeaſons*, that have ſome relation to the parts of the day, viz. *ſpring*, *ſummer*, *autumn*, and *winter*.

M. Pray do me the favour to explain to me, how *theſe changes* are brought about by this motion of the earth?

P. The deduction of this matter, I am afraid, will fatigue you; for you muſt attend to a variety of circumſtances at once: and after all, the ſubject does not afford much entertainment.

M. Is it not neceſſary to be known?

P. Scarce any thing can be more ſo.

M. Where then can I better beſtow a little attention.

P. Since

P. Since you are so resolved, we must go a good way back: wherefore tell me, do you know any of the *constellations* in the heavens by sight?

M. None, except the Pleiades, Orion, and the Greater Bear.

P. These are sufficient. Have you ever seen the Pleiades towards the end of the spring?

M. I do not indeed remember, whether I have observed them about that time or not.

P. It was impossible you could, Matho.

M. Why was it impossible?

P. I shall tell you; and that so much the more easily, as you were wont sometimes in your solitary walks to make a *tour* round the sun, together with the earth.

M. I did that in imagination only.

P. It will be necessary to do it in imagination over again.

M. I shall endeavour to follow you.

XXXVIII. *P.* When now the earth, in its annual course, is got between the sun and the Pleiades (for you remember that the fixt stars are far beyond the limits of Saturn, and so at a great distance without the earth's orbit;) when, I say, the earth hath got between the sun and *these stars*, they become observable in the night time, as not being intercepted from our sight by the sun's rays. And in this manner they appear during the whole winter; only they seem to get more westerly every night, as the earth moves gradually by them to the east.

M. This I easily conceive: for the sun and *they* being on opposite sides of the earth (or *he* within, and *they* far without its orbit) when it is night we are turned towards them, and then they must be conspicuous.

P. As the ſpring approaches, the earth by degrees withdraws itſelf, from between the ſun and them, and moves forward to the oppoſite part of its orbit: whence it comes to paſs that the ſun, placed in the center, ſeems to draw nearer to the Pleiades; till at length, the earth thus advancing in its courſe, the ſun gets between it and the ſtars, which then lie hid behind his rays.

M. This is extremely natural and eaſy to be apprehended.

P. And after the ſame manner, while the earth performs its annual courſe, the ſun, which always ſeems to move the contrary way, darkens, by his uncontrolable ſplendor, the other conſtellations ſucceſſively: but ſtill the ſtars oppoſite to thoſe thus intercepted (between which, to wit, and the ſun, the earth paſſes) become conſpicuous to it from behind. Thus from beholding the heavens in the night time, you may diſcover the relative motion between the ſun and the earth; and determine the real motion of the earth by the arguments I have given you before.

M. All this I can imagine without difficulty: the ſtars muſt come in view ſucceſſively on the part of the earth turned from the ſun, that is, in the night time, according as the earth advances in its orbit.

P. You are right; for after the Pleiades you will behold the glorious conſtellation Orion, and the Canicula, or Procyon, begin to ſhew themſelves towards the ſouth and eaſt; and upon the north the Twins, Caſtor and Pollux. As the year advances, the conſtellations of Leo and Hydra begin to appear. And from the ſouth Sirius, the brighteſt of all the ſtars, ſhews himſelf blazing fiercely below the equator; and far behind him,

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to the eaſt, the Cœleſtial Virgin with her Spica. Towards the end of winter, Arcturus comes in view, while Bootes drives about his *wain* from the north: at which time you may perceive almoſt all the ſtars of the greateſt ſplendor at one view. For Lyra and the Swan, as alſo Capella, Perſeus, with the Gorgon's Head, and all that beautiful region, either keep near the vertex of the ſky, or dip but little under the horizon.

M. O! what pleaſure it gives me to hear theſe things! I ſhall certainly endeavour to obſerve them with diligence, till I am in ſome meaſure acquainted with this pleaſant ſubject.

P. They will make your evening walks agreeable; nor can you procure yourſelf a more refined and innocent pleaſure: not to mention how ſtupid it is to neglect ſuch wonders in the heavens, as if we were bowed down like the groveling brutes.

M. Eſpecially when we make ſuch mighty boaſt of having ſeen this or the other lord's *fine houſe*, or *country-ſeat*.

P. If we had a conſtant and uniform *darkneſs* in the ether a-nights, Matho; if ſuch a ſight could only be ſeen by going to the antipodes, or appeared but one night in an age, who would not croud to the place, or watch for the time?

M. Men would then *croud* and *watch*, out of an unmeaning curioſity: but a rational ſpectator is not ſatiated with beholding by night, and meditating by day.

P. It is ſo; knowing the *uſes* and *ends* of what we behold can only make us put a juſt value upon them; otherwiſe they cloy and ſatiate, as baubles do an infant.

XXXIX. *M.* In the mean time, I think, I

can collect ſomething farther, from what you have ſaid.

P. What is it?

M. Since the ſun appears thus always to move the contrary way to the earth; ſince he darkens by his ſplendor that part of the heavens in which he is ſeen; and ſince the point of the heavens oppoſite to the ſun is that which is on our meridian at mid-night, as he is at mid-day, we may know from looking at the heavens themſelves at that hour (mid-night, to wit) both the point of the heavens in which our earth is, as being then on our meridian, and the point in which the ſun then ſeems to be, as being directly oppoſite to the other.

P. You hit the matter exactly. For if the firſt degree of Libra (that I may ſpeak of names of which you have not yet heard) be on our meridian at mid-night, the earth, to an eye placed at the ſun, would appear to be in that point; whence we know that the ſun is in the oppoſite point, or in the firſt degree of Aries, which happens about the 9th of March: and thus they proceed, occupying ſtill oppoſite points through all the following ſigns of the *zodiac*.

M. Though I am not quite a ſtranger to theſe names, yet pleaſe to make me better acquainted both with the *names*, and the *things* they ſignify.

P. That is but reaſonable.——This coeleſtial globe, you know, repreſents, on its convex ſurface, the concave face of the heavens. The great circle here, which cuts the equator obliquely, having one half of it raiſed to the north, and the other depreſſed towards the ſouth, is called the *ecliptic*. It is, indeed, the very orbit of the earth; but it ſeems to be, and is called the *way*

of

of the ſun, for a reaſon already often mentioned; becauſe the ſun ſeems always to move in the oppoſite point of the earth's orbit. It is divided into twelve equal parts, which are called *ſigns*. Theſe are known by the names of certain living creatures, which here you perceive painted in order, Aries, Taurus, Gemini, &c.

M. I have obſerved the names, and pictures of the creatures: but why is the circle itſelf called the *ecliptic?*

P. Becauſe the eclipſes of the ſun and moon happen in, or near it.

M. Does the ſun ever appear to move out of this circle, which, you ſay, is called the *way of the ſun?*

P. Never; but the moon's orbit cuts it at a ſmall angle, whence ſhe moves always a little out of it, except in the points of interſection; the conſideration of which matter is foreign to our preſent purpoſe.

M. I have a notion of the eclipſe of the moon, that it happens by her paſſing through the earth's ſhadow, as you ſhewed me before.

P. Well; the eclipſe of the ſun is occaſioned by the interpoſition of the dark body of the moon, between *him* and us: and as the one happens in, or near the *full*, ſo the other can only happen in the *change* of the moon.

M. I now, indeed, remember, I ſaw a notable eclipſe of the ſun ſome time ago; and heard people talking much about it. A ſmall ring of the ſun's body ſhone round the moon; whence, I perceive, he muſt be at leaſt larger than the moon.

P. And that not a little, if you conſider at what a vaſt diſtance he is beyond our ſatellite.

M. It muſt be ſo. I hope I ſhall ſoon have the pleaſure of underſtanding theſe things better.

P. To return: you are chiefly to take notice of four points of the ecliptic, becauſe much depends on the knowledge of theſe.

M. What are they?

P. The firſt of Aries and Libra, which are called the *equinoctial points*; becauſe when the ſun, or rather the earth, is in theſe, the days and nights are equal to all the inhabitants of the globe: and the firſt of Cancer and Capricorn, which are called the *ſolſtitial points*.

M. I perceive the points themſelves on the globe, and think I know the reaſon why the laſt are called *ſolſtitial*.

P. The reaſon is not hard to be found out.

M. Since the ſun in theſe points of the ecliptic is fartheſt diſtant from the equator, either to the north or ſouth, before he begins to return, he ſeems to ſtand a little, his motion poſſibly appearing then ſlower.

P. It is ſo, indeed. And from his turning back at theſe points, thoſe two leſſer circles, parallel to the equator, are called *tropics*; for the word ſignifies *turning back*. When he comes to the *tropic of Cancer*, it is our ſummer ſolſtice; and we have then the longeſt day, and the ſhorteſt night: but when he is got down to the *tropic of Capricorn*, or winter ſolſtice, our days are ſhorteſt, and nights longeſt.

M. It is but reaſonable, I perceive, that theſe points ſhould be chiefly taken notice of; ſince when the ſun is in theſe (or rather the earth, as you obſerved) he either makes our days and nights equal, or gives one of them their greateſt length; ſo that our moſt remarkable changes begin from them.

P. The

P. The obſervation is juſt. Laſtly, you perceive here the *polar circles*, as far diſtant from their reſpective poles, as the ecliptic declines from the equator, which diſtance you may yourſelf meaſure on the brazen meridian.

M. It ſeems to be about twenty-three degrees.

P. And almoſt a half.

XL. *M.* Thus far, I think, I underſtand: but how are we to find out in the heavens themſelves thoſe ſigns of the zodiac, where certainly there are no effigies of the creatures, whoſe names the ſigns bear, as on this painted globe?

P. The *four points* we have been ſpeaking of are known and determined by aſtronomical obſervations; and the degrees are reckoned from the firſt of Aries eaſtward, or through the *following ſigns* (as they uſed to ſpeak) there being in every ſign thirty degrees. Hence the ſigns themſelves are known and limited; ſince each of them takes up the twelfth part of the ecliptic. And thus it is known what ſtars are contained within ſuch a ſpace, ſo that they can be reduced to their proper ſign, and the degree of that ſign: and when once a few are known, we come to the knowledge of the reſt without much difficulty. As for example, the Pleiades we ſpoke of are in the twenty-ſixth degree of Aries, and four degrees diſtant from the ecliptic northward. From theſe you will eaſily diſcover both the *names* and *places* of the neareſt ſtars, and from theſe again others; remembering always to make yourſelf acquainted with the ſtars of the greateſt magnitude firſt, for theſe will direct you beſt. And thus you may make a *map* as it were of this part of the heaven.

M. To that purpoſe this *artificial globe*, I preſume, will be of uſe.

P. Of

P. Of very great uſe: for on it you have the names and places of the ſtars marked according to the lateſt obſervations.

M. And the *heavens* and *globe* are to be conſulted by turns.

P. That will be proper: only you muſt firſt underſtand ſo to ſet, or rectify the poſition of the globe, that it may repreſent the face of the heavens at any particular time. You will alſo eaſily ſee that the winter time, and the long and clear nights, are fitteſt for this purpoſe: you may then have the proſpect of the whole converſion of the heavens almoſt in one night. But a friend will ſhew you more in two or three evenings, than you could otherwiſe find out by yourſelf in a long time. After that, a little practice will make the thing both eaſy and agreeable. That ſeaſon will always return with pleaſure to you: every year will renew your former acquaintance: you will have a chearful temper, and find rational entertainment, while others are eaten up with the ſpleen and vapours.

M. I ſhall long exceedingly for that ſeaſon.

P. You will find it more difficult to obſerve the ſtars when near the horizon, than when they are got higher up; for the air is more groſs and thick, while we direct our view along the ſurface of the earth. And for the ſame reaſon, ſtars, not far diſtant from each other, when near their greateſt altitude, ſeem farther ſeparated while they riſe in the eaſt, or go down on the other ſide; which you will obſerve at firſt, not without ſome ſurprize.

M. I have, indeed, obſerved a *tree*, or a *man*, to appear taller and larger, ſeen through a foggy air, than when it was perfectly clear.

P. Even when the air is cleareſt, it is ſtill thicker near the earth, becauſe of the vapours conſtantly riſing: and when you look at an object on the horizon, the eye encounters more of this thickneſs, than by looking higher upward.

M. Poſſibly, it is this thickneſs of the air near the earth, that makes diſtant mountains appear bluiſh; and, if a great way off, ſcarce diſtinguiſhable from the *blue ether*.

P. It is very well obſerved, Matho; and this ſhews us that the *atmoſphere* becomes purer and finer, the higher it riſes. If it were as groſs for forty or fifty miles ſtraight upward, as for an equal diſtance outward, or near the ſurface of the ground, we ſhould neither enjoy the light of the heavenly bodies ſo pure, nor the heat of the ſun to ſuch a degree, as at preſent. The ſun would often appear coloured, with his edges well defined, the ſtrength of his rays being taken off, as ſometimes he appears now when near the ſetting.

M. I am glad of having ſtumbled on the obſervation: what you ſay ſatisfies me, that the higher air becomes ſtill more clear and tranſparent: it muſt have been very uncomfortable, if our heat and light had been thus greatly abated. And from this, I think, we may infer, that the altitude of the atmoſphere cannot be very great.

P. Indeed, Matho, that is uncertain. The air is a *ſpringy*, or *elaſtic* fluid: the uppear parts of it, therefore, muſt be at ſuch diſtance from the earth, that their gravitation to it, and repulſe from the lower particles, may be *in equilibrio*. Their attraction to the earth can *there* be but very ſmall, and their repelling force is exceeding great.

M. Leaving that affair then; in turning round the globe here, I perceive the ſeveral ſigns do not keep within their own limits. *P.* There

P. There are ſome niceties obſerved about the equinoctial points, which is not worth your while to dwell upon at firſt.

XLI. *M.* Things then being, I preſume, rightly prepared, pray ſhew me how the great changes in nature, and the diverſity of ſeaſons, are brought about by the annual motion of the earth.

P. In order to this you muſt imagine yourſelf in good earneſt to be carried round the ſun, with the earth, for one whole revolution.

M. Since you have ſhewed me that we are thus conſtantly carried round him, it is only imagining a real matter of fact, drawn into a narrower compaſs.

P. It will be proper to begin from the firſt degree of Libra: for the earth being there, the ſun muſt appear in the firſt degree of Aries; and you may fancy that this is the ninth of March, or vernal equinox.

M. Let us ſet out then.

P. Call to mind, likewiſe, that the axis of the earth points conſtantly to the pole of the heaven; that *point*, namely, which ſeems immoveable in the earth's diurnal revolution; for by this means it happens (becauſe of the immenſe diſtance of the heavens) that the axis keeps ſtill parallel to itſelf.

M. This I do not underſtand; pray explain it a little.

P. I imagine a diameter drawn through the earth's orbit, from north to ſouth, or from the firſt of Cancer to the firſt of Capricorn: and if the earth's axis was produced, when it is in the extremities of that diameter, the two *productions* would

would meet in the pole of the heavens, and with that diameter form a triangle: and yet the axis in both theſe poſitions ſeems exactly parallel to itſelf.

M. When its productions make the two ſides of a triangle?

P. Even in that caſe.

M. This I cannot comprehend, unleſs I ſhould ſuppoſe theſe two ſides immenſely long, and the diameter of the earth's orbit extremely ſhort, with reſpect to either of them, or like a point between them.

P. That is indeed the very caſe.

M. Then it ſeems the whole diameter of the earth's orbit is as little, with reſpect to the diſtance of the heavens, as the ſemidiameter of the earth is, with reſpect to the diſtance of the ſun.

P. It is ſo.

M. This is amazing! We can ſcarce form a right notion of the diſtance of the ſun, which yet is but as a point in compariſon to the other. At that rate the whole planetary ſyſtem muſt be but a ſmall thing, compared with the ſtupendous concave of the fixt ſtars.

P. Leſs than a *nut-ſhell*, compared with ſome *ſpacious dome*.

M. I muſt remember this, and think of it more at leiſure.——

P. Here likewiſe is an eaſy, intelligible figure of the whole annual revolution, which will ſomewhat help your imagination.

M. I perceive there Aries on our right hand, and Libra, whence we are to ſet out, on our left: and I fancy we are to move according to the order of the ſigns, or towards Capricorn.——

P. Laſtly, remember, that the earth rolls round

on its axis, or performs the diurnal revolution, all the time it is carried round the ſun. For if that larger globe repreſented the ſun, and this *ſmall one* the earth, it is as if I carried the little one round the bigger, and at the ſame time turned it on its axis.

M. I underſtand: but all theſe various admonitions put me in mind of Phœbus's tedious advices to his ſon, before he would permit him to mount the chariot.

P. We are juſt going to ſtart. But firſt, obſerve how things are, in the poſition the earth is in at preſent: for, becauſe the equator of the earth is now exactly oppoſed to the ſun, and he enlightens always a *hemiſphere*, or half of its ſurface, his rays will reach to both poles. Whence, from the diurnal revolution of the earth, the days and nights are equal all over the globe.

M. You told me before, it was ſo at both equinoxes, and now I perceive the reaſon of it; we are in the rays of the ſun for one half the diurnal revolution, and in the ſhadow of the earth, or dark, for the other half.

P. It is ſo; let us now ſet forward; and as we proceed daily with the earth toward the ſouth, through Libra, Scorpio, and Sagittary, to the beginning of Capricorn, the ſun ſeems to riſe above the equator, and move to the north, through the oppoſite ſigns Aries, Taurus, and Gemini, to the beginning of Cancer.

M. Not ſo faſt.——The earth, you ſay, is now on the ſouth ſide of the ſun. Why?—Becauſe its axis, always reſpecting the north pole of the heavens, is now more turned to him: therefore he muſt be on the north of the earth.

P. So far you are right.

M. And

M. And this is the reaſon why he ſeems to riſe higher to us: for, ſince over our heads is always *upward* to us, as the axis (keeping parallel to itſelf) turns us more to him, he appears to riſe higher above us. And for the ſame reaſon, the ſouth pole turning from him, he ſeems to fall lower to them.

P. You conceive perfectly well what effect the parallelism of the earth's axis has. Now ſince the ſun began to riſe through the northern ſigns; that is, ſince the earth began to be among the ſouthern ſigns, and ſo turned its north pole more to the ſun; his rays fall ſhort of the ſouth pole, and reach beyond our north pole, and that daily more and more, as the ſun ſeems to riſe higher. Whence it comes to paſs (the earth ſtill continuing to roll on its axis) that the days grow always longer with us in the north parts of the earth, and ſhorter to thoſe who live on the other ſide the equator.

M. I underſtand; for now it happens that on this ſide of it, the greateſt part of the diurnal revolution is performed in the light of the ſun; but on the other ſide, the greateſt part is performed in the ſhadow of the earth. Whence I ſuppoſe their nights muſt grow equally long with our days, and their days grow ſhort with our nights.

P. It is, indeed, exactly ſo.——When the ſun has at length reached the beginning of Cancer, and we are come to the firſt of Capricorn; that is, when he ſeems to have got to the northmoſt point, and we are really in the ſouthmoſt point of the earth's orbit, our days are at the longeſt, and theirs on the other ſide the equator are at the ſhorteſt.

M. And

M. And how far do the ſun's rays reach there beyond the north pole?

P. Juſt as far as he ſeems to have riſen above the equator; that is, to the farther ſide of the arctic circle; and, on the oppoſite part, they reach only to the nearer ſide of the antarctic circle. Whence the firſt is all in the light, and the laſt all in the earth's ſhadow.

M. I ſhould have perceived this, without aſking you the queſtion. For ſince he always illuminates a hemiſphere, or half of the earth's ſurface, he muſt ſhine as far beyond the one pole, as he has advanced nearer it; and as far ſhort of the other, as he has receded from it.

P. And now we are at the tenth of June; for the earth has performed in the interim about ninety-three revolutions on its own axis.

M. Thus far, I think, I conceive perfectly.

P. And now, Matho, that we are on the ſouthmoſt point of the earth's orbit, let us imagine that we obſerve the *altitude* of the pole, and mark it down.

M. To what purpoſe?

P. You will ſee immediately.

XLII. Having thus travelled with the earth through the firſt quadrant of the ecliptic; from the tropic of Capricorn, we begin to move eaſtward, through Aquarius and Piſces, to the firſt of Aries; and the ſun the contrary way, from the tropic of Cancer, through Leo and Virgo, to the firſt of Libra.

M. Let me, if you pleaſe, conſider the earth's motion in this quadrant.——Its axis always reſpecting the north, or keeping parallel to itſelf; and the ſun ſeeming to move weſtward, as we advance

advance eaſtward; the inclination of the axis northward will gradually ceaſe to be turned to him: ſo he muſt loſe of his altitude, or ſeem to deſcend to the equator again, by the ſame degrees as he ſeemed to riſe above it in the former quadrant.

P. You expreſs the appearances with much propriety. And as to the length of the days and nights?——

M. The days muſt be ſhortened from the ſolſtice to the autumnal equinox, in the ſame manner as they were lengthened from the vernal equinox to the ſolſtice: for it is eaſily ſeen that the ſun muſt enlighten the earth in the ſame manner when he returns to the equator, as when he departed from it.

P. Becauſe in equal diſtances from the ſolſtice the earth's axis is equally inclined to the ſun; ſo that its motion through this quadrant is only the converſe of its motion in the laſt.

M. That makes it ſo eaſy to be apprehended: the only difficulty is to conceive it in the firſt quadrant. And now that we are come to the firſt of Aries, the days and nights muſt be equal again; as when we ſet out from the firſt of Libra.

P. One particular here however is worth your notice.

M. What is it?

P. The arctic pole hath been in the light of the ſun, all the time from the vernal to the autumnal equinox; that is, all the time the ſun hath been among the ſix northern ſigns.

M. This is abundantly obvious: for as ſoon as the earth moved by the firſt of Libra, his rays reached beyond the pole; nor have they yet left it, when we are got to the beginning of Aries.

P. And

P. And the ſouth pole hath been all the time in the dark.

M. That is equally plain: but the ſun will make up its loſſes when he is among the ſouthern ſigns.

P. He will indeed.

M. And hence it follows, that at the poles of the earth there is but one day and one night in the whole year.

P. You are ſo ready in theſe things, Matho, that I think we need go no farther in the annual revolution.

M. By all means finiſh the earth's courſe.——

P. We leave the firſt of Aries then on the 12th of September, and the earth begins to move north from the ſun: our pole now is turned gradually away from him, becauſe of the conſtant inclination of the axis northward, and the ſouth pole is turned more to him. Whence he ſeems to fall down below the equator to us, and to riſe higher to thoſe on the other ſide of it; for over their heads is *upward* to them likewiſe. In this quadrant the night is lengthened the ſame way, as the day was from the oppoſite equinox, till the ſun arrives at the beginning of Capricorn, by our being carried to the firſt of Cancer, which is on the 11th of December. And then our night is become as long as our day was in the oppoſite ſolſtice; and the day as ſhort as the night was then.

M. What a beautiful regularity there is in all this motion!

P. Being now come to the northmoſt point of the earth's orbit, let us obſerve the altitude of the pole again; and we ſhall not find it raiſed any higher, than in the oppoſite point; though we have

have been carried towards it by the whole length of a diameter of the *magnus orbis*.

M. I ſhall ſurely remember the obſervation: by it I ſee clearly that *that diameter*, how long ſoever, is but as a point compared with the diſtance of the fixt ſtars.——

P. In this ſituation of our globe, nature ſeems to lour upon us; and we ſuffer in our turn the rigours of the hard ſeaſon. Our rivers are frozen over, and the earth is covered with deep ſnow: while on the other ſide the equator ſummer reigns, and the wearied inhabitants ſeek the ſhade to ſkreen them from the ſcorching heat of the noon-day ſun.

M. By the ſame wonderful motion of our globe, I ſee the bounty and ſmiles of nature reach all its inhabitants!

P. From this chill ſolſtice we begin to move ſouth, and the ſun ſeems to return northward; till the earth, coming again to the firſt of Libra, finiſhes its annual courſe, having in the mean time performed about 365 revolutions on its axis, and thereby divided the year into as many days.

XLIII. *M.* Now, Philon, you have made me maſter of the thing I ſo much deſired. The earth's motion from ſouth to north of the ſun, with the paralleliſm of its axis, are as pleaſant as new to me. Nothing could have given me a clearer view of this *grand revolution*, unleſs I had been taken up into the heavens, and beheld the whole annual courſe from ſome convenient *ſtation* on high.

P. You are to make the *ſame tour* then by yourſelf, I ſuppoſe, ſince you are ſo mightily pleaſed with the ſpeculation.

M. Not once, I aſſure you, nor confined to theſe

theſe *little draughts* on paper; but under the open heaven, where I ſhall have ſcope. And at no time of the year can I thus go round the zodiac, but I muſt come to the place where we then really are. There I will ſtop, and conſider the face of things in that poſition of our globe; and by doing this frequently, the heavens themſelves will at length become my *diagram*.

P. This will be an agreeable-enough *paſs-time*, Matho, when you happen to be cloyed with your other diverſions, as you owned was the caſe ſometimes.

M. I have even been ſometimes ſick of myſelf, Philon, having nothing to do that I could take a pleaſure in: and if that be the *ſpleen* or *vapours* you ſpeak of, it is a bad-enough diſeaſe.

P. So much the worſe, as it beſpeaks a weak and feeble mind.

M. I am obliged to you for teaching me how to prevent it.—But tell me, what would the face of things be, if the equator and ecliptic coincided into one?

P. You have already found out things more difficult than this: wherefore imagine your ſuppoſition to be reality, and then try to anſwer your own queſtion.

M. My lazineſs deſerves a ſeverer reproof: pray obſerve then if I can repreſent the conſequences of ſuch a caſe juſtly.——The ſun would be conſtantly on the equator; therefore there would be a conſtant equinox, or equality of night and day, all the earth over: in the ſame place there could be no diverſity of ſeaſons, becauſe the ſun would ſtill be at the ſame diſtance from them: and laſtly, we might diſcover the *limits of the year*, that is, the end of a revolution of the earth round the

the ſun, by the ſtars ſeen in the night time, on the ſide of the earth turned from the ſun; but not eaſily by his apparent motion by day. And indeed, in that caſe, the annual motion of the earth round the ſun would be, I think, almoſt needleſs; ſince we ſhould have the ſame degree of heat and light from him, if the earth ſtood ſtill in the ſame part, and revolved on its axis, as at preſent: only we could then have but one face of the heavens, and the ſame ſtars conſtantly expoſed to our view in the night time: which (if you would not think me a little vain) I own I ſhould be ſorry for: and I am ſure the contemplative part of mankind would reckon it a prodigious loſs.

P. You have deduced the conſequences very juſtly, Matho: but what ſhould we gain or loſe by this change of conſtitution?

M. We ſhould loſe, I think, a great deal. At the equator and neighbouring parts all things would be violently ſcorched with the ſun conſtantly over their heads: in theſe parts where we live, it is to be doubted if we could have any grain, any harveſt, or ripeneſs of vegetables, having never more heat than now about the middle of March: elſewhere, eternal winter, without the hopes of a returning ſpring, would baniſh mankind from a great part of the habitable globe. And certainly it is wonderful that from ſuch a ſmall obliquity of the ecliptic, ſo many agreeable viciſſitudes, and ſuch advantages to mankind, ſhould ariſe!

P. Your reflection is well grounded; and ſo it is for the moſt part; we do not attend to the advantages of our preſent conſtitution, till we conſider fairly the conſequences that would enſue on a change.——

M. But what are we to think of the other planets? Do they enjoy the same vicissitudes?

P. The same, or at least not much different; they are dark bodies like our earth; have a diurnal rotation on their own axis; and are, like our earth, carried round the sun. These *like circumstances* must produce the same changes *in kind*, though perhaps not the same *in degree*. In Jupiter and Mars, the ecliptic nearly coincides with the equator: in Saturn these two circles decline farther from each other, than on our earth. Whence the first two planets have a less difference of summer and winter than what we enjoy; but the last a greater. And, on what account soever we may suppose a diurnal revolution to be given to Jupiter and Mars, there will be still greater reason for allowing it in Saturn; if it be at all proper to speak of the equator of a planet without such a revolution.

M. But how should one know these planets from other stars, since they do not keep the same place, but move, as our earth does, through the consequent signs of the zodiac?

P. That very circumstance makes it easy to know them. For on a very little acquaintance with the heavens, you will be surprised to find a great star in any part of them, which uses not to be there. You will soon become acquainted with their courses and periods, and know in what part of the heavens they ought to be found. And if you would have more exactness, you may have recourse to the astronomical tables: it will give you the greatest pleasure to be able to calculate before hand, where they must be at any given time.

M. You double my curiosity, by flattering my hopes

hopes ſo agreeably.——But as we have gone through a good many different ſubjects in this conference, if you pleaſe I would retire, and try to recollect them, while they are freſh in my memory.

P. I am ſatisfied, and wiſh you good ſucceſs, Matho: theſe ſubjects are but dry and un-entertaining.

M. If I can make them plain to myſelf, that will make them pleaſant. Beſides, I think you artfully decried the deſcription of the annual motion, that I might be the more ſurpriſed with the agreeableneſs and variety of the things repreſented.

THE

Fourth CONFERENCE.

From the conſideration of the beauty *and* order *of the planetary ſyſtem, Matho is led to enquire how it began at firſt to be; or who was the* author *of ſuch a work? The reaſons are laid down by which this may be diſcovered. That the planets are conſtantly impelled by two diſtinct forces, without which they could not revolve in orbits about the ſun: that any body of itſelf reſiſts to revolve about a center: that* gravitation, *and the* attraction *of* coheſion, *cannot be the effects of matter, or any mechanical cauſe, ſhewn from variety of arguments. Hence Matho diſcovers that theſe effects muſt proceed from the immediate power of the Deity. The* unity *and* abſolute perfections *of the Supreme Being deduced in a plain and natural way.*

XLIV. *P.* SHALL I congratulate Matho on his ſafe return from the ſtarry regions?

M. You may, if you pleaſe, though I found every thing ſafe and agreeable. The Bull, the Scorpion, the cœleſtial Archer, and all the poetical monſters diſappeared: my only ſolicitude was, to conceive rightly the annual and diurnal motions of the earth, and how theſe occaſion the viciſſitudes we obſerve in nature. This I in ſome ſort accompliſhed: but now an affair of greater moment takes up my thoughts.

P. What

P. What may that be?

M. When I conſider attentively this *vaſt frame* of the planets, ſo ſimple in its order, and yet find that this ſimplicity is the ſource of ſuch variety, I am perfectly aſtoniſhed. Wherefore let me aſk you, how ſuch a frame began at firſt to be; or by what force theſe *prodigious bodies* are thus conſtantly driven round the ſun, and detained in their orbits? I find I cannot be eaſy till I know the cauſe and origin of theſe motions.

P. You may aſk what you pleaſe, Matho; but I am reſolved to anſwer in my own way.

M. What is the meaning of this, Philon!

P. The meaning of it is, that I am not willing to diſappoint you by a plain and ready anſwer.

M. That meaning is above my comprehenſion.

P. The caſe ſtands thus; a queſtion of ſuch importance is not to be anſwered in a word, like *facts*, for which no other reaſon can be given, but that they ſo happen: here we muſt proceed at leiſure, that the truth may rather appear from the reaſons on which it is founded, than be delivered in bare words, as when a ſchool-maſter teaches a child.

M. I remember you told me ſomething like this before, and it is certainly a right method: but as it is a long time ſince you firſt ſaid ſo, pleaſe to tell me now more fully the reaſons that lead to the true anſwer of this queſtion.

P. Even that I am not diſpoſed to do.

M. Then I perceive I can expect but little ſatisfaction in a point, which you yourſelf own to be of the greateſt importance.

P. You are to proceed thus, Matho; tell me frankly what common ſenſe ſuggeſts to you con-

cerning the motions of theſe heavenly bodies: I ſhall ſurely oppoſe you tooth and nail; but do you maintain your own ſide of the queſtion, as far as reaſon can ſupport you.

M. This is a very unequal match, and not a great deal to your credit, I think.

P. The match, I am afraid, is not ſo unequal as it would be: however, it will be of ſome advantage to me, to hear the ſentiments of plain and unbiaſſed nature, on ſuch a ſubject. For it is here, as in life, we men live according to the mode, and argue from authority: ſo that though I loſe in the main, I ſhall gain in hearing your natural ſentiments.

M. Without replying to theſe flouriſhes, I think ſome mighty force muſt be neceſſary, to put thoſe huge bodies once in motion; and then they ſtand in need of a conſtant direction, otherwiſe they would every minute leave their orbits; ſince no body of itſelf can revolve about another in a free ſpace.

P. What ſhould hinder it?

M. What ſhould hinder it!——Is it neceſſary that it ſhould of itſelf ſo revolve in a free ſpace?

P. I do not ſay it is.

M. It is your buſineſs then, I think, rather to ſhew me what ſhould cauſe it, than mine to ſhew you what ſhould hinder it. For if there be no cauſe to produce the effect, though there be nothing to hinder it, the effect can never be produced: nor can there be a greater impediment to any thing, than the want of a cauſe to produce it.

P. It may be ſo.

M. Nay, it cannot be otherwiſe. I perceive, Philon, you are endeavouring to puzzle me; but I can

I can maintain this againſt you, or any body elſe. Beſides, I know from a hundred different inſtances in my diverſions, that if I ſtrike a ball, or any ſuch thing, it goes ſtraight forward, but never moves in a circle. I remember nothing that moves in a circle, except when we drive a ſtone round in a ſling; or perhaps when ſome light body is carried round in a *whirl* of water; which certainly is not applicable to the planets deſcribing circular orbits in free ſpaces.

P. How do you know that the ſpaces in which the planets move are free? They may be full of a ſubtle matter.

M. Look you, Philon, I am yet but a raw diſputant, and know not all your arts of diſconcerting people; nor ſhall I ever ſtudy them, ſince I think they only obſtruct the diſcovery of truth: but this I know from experience, that our earth, for inſtance, is ſurrounded with no ſuch denſe matter, as could keep it within the limits of its orbit, which it muſt endeavour conſtantly to break through by its rapid motion *. Beſides, ſuppoſing that ſome ſuch impalpable ſtuff, as this ſubtle matter of yours, could drive the planets round, what, I pray you, muſt drive this matter round, and every particle of it? This increaſes the difficulty. And if you ſhould ſay that this matter does not move round with the planet, but ſtands ſtill, it muſt, by its reſiſtance, ſtop the motion of the revolving body, inſtead of keeping it within its orbit; which increaſes the difficulty another way. Nor have I forgot, when I ſay this, what you

* *Corpora, quæ in vortice delata in orbem redeunt, ejuſdem ſunt denſitatis cum vortice, & eadem lege ſunt ipſius partibus quoad velocitatem & curſus determinationem mouentur.* Prop. 53. Lib. 2. Princip. D. Newton.

told me concerning the atmoſphere's ſurrounding the earth: but it reaches to no great height, and partakes as well of the earth's annual, as diurnal motion. And its annual motion remains to be accounted for, as much as the earth's; ſince its diurnal motion could not be otherwiſe accounted for, than the earth's was.

P. Theſe are the things, Matho, which I was deſirous of hearing from yourſelf. You are ſooner and more ſtrongly convinced, by entering into the diſcuſſion of particulars, and diſcovering the reaſons of them yourſelf, than you could have been by hearing the ſame things from me: and as this is the moſt effectual, ſo it is by far the ſhorteſt method.

M. Tell me then by *what force*, or the *direction* of what cauſe, the planets thus continue to move round the ſun in circular orbits?

P. By no force, and the direction of no cauſe at all.

M. And yet I have ſhewn you juſt now, that a body muſt go ſtraight forward, and cannot move in a circle, unleſs it be conſtantly kept in, as a ſtone is by the ſling.

P. But pray take care, leſt your diverſions deceive you in this point.

M. Which way?

P. When you throw a ſtone ſtraight forward, it doth not move ſtraight forward; but always draws nearer the earth, and at laſt falls on it.

M. It is ſo, indeed. But hold a little.—— This is excellent! How oft have you told me, that the action of *falling downward*, is not the action of the body itſelf which falls, but the effect of another cauſe? This is what I am contending

tending for, and your inſtance to the contrary makes againſt yourſelf.

P. I ſee you are flusht with ſucceſs, Matho: but leaving this inſtance as we found it, what would you ſay, if I ſhould deny that there was any cauſe that kept the ſtone to a circular motion, while it is whirled round in the ſling?

M. If you denied ſuch a cauſe in good earneſt, I could eaſily convince you, provided you could be convinced by reaſon.

P. Convince me if you can.

XLV. *M.* I ſhall not ſtay then to obſerve that you ſeem to deny this *fact* in a very contradictory manner; but aſk you, if a ſtone put into a ſling could move in any manner without *ſome hand?*

P. It could not.

M. And then, could it move round in a circular ſpace, if the ſling did not conſtantly keep it within thoſe bounds?

P. I cannot tell.

M. Come ſpeak ingènuouſly, Philon: I undertook only to convince you, provided you would ſtand to reaſon.——For tell me what happens, if you let the ſtring go?

P. The ſtone immediately flies out.

M. Doth not therefore the ſtring conſtantly impreſs *another force* upon the ſtone, in drawing it ſtill back to the hand, as it were the *center* of its motion?

P. I own it does.

M. The ſtone then is conſtantly preſſed, or urged by *two contrary forces:* by the *one*, it would inceſſantly fly out, this belongs to the ſtone itſelf; and by the *other*, it is as inceſſantly kept in, this

is the action of the ſtring. Have you any thing to reply to this?

P. Nothing.

M. There is another conſideration, likewiſe, that confirms all this, and in which any boy would be able to give you ſatisfaction.

P. Pray let me hear it.

M. If we whirl round the ſtone with more velocity, it ſometimes happens that the ſtring breaks; which ſhews, that as the circular motion becomes ſwifter, the *centrifugal force* (as I now remember you called it before, when ſpeaking of the ring twirled round on the table) becomes ſtronger.

P. It does certainly, otherwiſe the ſtring would not break.

M. And muſt not this increaſe of centrifugal force require an equal increaſe of contrary force to keep the ſtone to its orbit?

P. It muſt.——And now, Matho, you have convinced me ſufficiently; but at the ſame time you have taught me how I may convince you, if you ſhould deny again any of theſe things, you have juſt now affirmed.

M. That I ſhall be very far from doing: but pray what do you mean by ſuch an inſinuation?

P. I ſay, that this our earth, and every one of the planets, is conſtantly urged or impelled by two different forces; *one* which always drives the planet ſtraight forward, and *another* which keeps it conſtantly from running out, by retracting it towards the ſun, the *center* of its motion. What do you think of this?

M. I think it is eaſier to affirm than to prove it.

P. What do you deny in it?——Well, ſince you ſeem in doubt what to deny, tell me, would the earth placed at this diſtance from the ſun move

any

any way without *ſome hand*; that is, without a force impreſſed upon it by *ſome cauſe*?

M. It would certainly remain there for ever.

P. Would it begin to move forward, think you, or backward? upward or downward?

M. I own it could move no way, more than the ſtone in the ſling.

P. *Some* HAND therefore (whatever that may be) impreſſes *one force* upon the earth.

M. I own it.

P. But if only one force were impreſſed upon it, driving it ſtraight forward, what would happen? Would it keep to a circular orbit, if another force did not conſtantly draw it towards the center?

M. It could not of itſelf keep to a circular orbit, more than the ſtone.

P. For if no other force acted, what would enſue?

M. It would undoubtedly begin to leave its orbit that inſtant.

P. Does not therefore ſome HAND inceſſantly impreſs a *ſecond force*, to prevent——

M. It is enough, Philon; I always forgot to make the application from common inſtances, where our own experience is judge, to other caſes leſs attended to; though the ſame reaſons are applicable to both: but now I ſee there is an equal neceſſity for the conſtant impreſſion of both forces, as well in the revolution of ſuch vaſt bodies as our earth, as in this ordinary experiment. And indeed, this is the notion I myſelf had at firſt; though I did not perceive the two different forces ſo diſtinctly, nor was I ſo much ſatisfied about the reality of them.

P. For can a body, the greater it is, require leſs force to give it any ſort of motion?

M. It requires a greater, ſurely, and that in proportion to its magnitude.

P. Since then a ſtone twice as big would require double force, and one thrice as big triple force, and ſo on; conſider with yourſelf, how great that force muſt be, which drives round, and keeps to a circular motion, ſuch a body as the earth, loaded with ſuch vaſt mountains, and prodigious rocks, and flying with ſuch rapidity.

M. Such force is above our eſtimation, becauſe we know nothing can be compared with it. Yet I ſhould have ſomewhat a juſter notion of it, if I knew what the earth's velocity in its orbit were.

P. It would be an eaſy matter to ſhew you that, if we were certain of its true diſtance from the ſun. But, as I have ſaid before, that diſtance is hitherto undetermined.

M. However, ſatisfy my curioſity ſo far, as to tell me its velocity, on the common ſuppoſition?

P. If the middle diſtance of the earth from the ſun be twenty thouſand of its own ſemidiameters, its mean motion in its annual orbit is nine hundred and fifty-three Engliſh miles in a minute: but if its diſtance be twenty-one thouſand of thoſe ſemidameters (which comes nearer the general ſuppoſition) in a minute of time it flies full a thouſand miles.

M. This raiſes my aſtoniſhment above expreſſion. If I conſider a prodigious body, near eight thouſand miles in diameter, ſhooting through the ether at the rate of ſixty thouſand miles in an hour, and that we ourſelves are carried along with it.——But is this to be depended upon?

P. If that be the true diſtance of the earth from the ſun (and ſome have made the diſtance between them

them much greater) this velocity of it is as certain, as it is that it moves at all.

M. This looks like the exaggerations I have heard of in ſome of the Mahometan legends.

P. Thoſe legends, Matho, are only the productions of an ignorant and irregular fancy: but alas! the moſt unbounded fancy is narrow, in reſpect of the power of that cauſe, which we have now under conſideration.

M. I ſhall not be able, for ſome time, to get over the amazement this particular has thrown me into.

XLVI. *P.* It is proper, before you go farther, to let you know, that the one of theſe forces, which prevents the planets from running out in ſtraight lines, by drawing them conſtantly inward to the center of their motion, is called by philoſophers the *centripetal force*; and the other, by which they would run out, is called the *excurſory* or *projectile force*.

M. Theſe names expreſs the difference of the two forces very clearly.

P. As to the obſervation which you boys make, that when you whirl the ſtone about with more velocity, its centrifugal force becomes the greater, it is very much to the purpoſe: for, as you rightly obſerve, the centripetal force (or the ſtretching of the ſtring to keep it in) is increaſed equally. Therefore knowing the quantity (or ſtrength) of one of theſe forces, you muſt always know the other; and you will find the increaſe of the centrifugal force very regular, according to the increaſe of velocity; which may be of great uſe to you hereafter.

M. I little thought our diverſions could have been ſo uſeful to us in theſe matters.

P. As

P. As it is of conſequence to you to be familiarly acquainted with the neceſſity for theſe forces, pray anſwer me a few queſtions.

M. Aſk what you have a mind.

P. If neither of theſe two forces were impreſſed upon a planet, what would follow?

M. Nothing; for the planet would reſt in the ſame place, as much as the ſtone did in the ſling, when no hand moved it.

P. If the centripetal force were only impreſſed, what then would be the conſequence?

M. The planet would ſtraightway be drawn down towards the ſun.

P. If only the projectile force acted?

M. It would run out through the cœleſtial regions, without let or hindrance.

P. If ſome HAND ſhould impreſs both forces together, ſo that neither of them could overcome the other, what would be the effect?

M. The planet could neither draw nearer the ſun, being hindered by the excurſory tendency; nor run out to a greater diſtance from him, being kept in by the centripetal impreſſion; but muſt neceſſarily revolve in a circle.

P. But perhaps it is not neceſſary that both forces ſhould act upon the planet inceſſantly, and every moment?

M. It is as neceſſary here as in the experiment of the ſling: for in the inſtant either of theſe forces ceaſed to act, one of the two conſequences juſt now mentioned would follow. Our earth, for inſtance, would either be drawn down towards the ſun, or fly out through the cœleſtial ſpaces.

P. You ſee then of what difficulty it is, and what force it conſtantly requires, to make a body revolve about a center in a free ſpace.

M. I

M. I ſee this ſo clearly, that (if the body be a planet) I have not words to expreſs how difficult and wonderful an effect it is, and what the force muſt be; ſince any little pebble, driven round a center, requires the conſtant action of an *external cauſe*, and that acting in two very different manners. But the more difficult this effect is, ſo much the more impatient am I to know the origin of ſuch force, ſo juſtly applied: I beg therefore you would not keep me any longer in ſuſpence.

P. Why ſhould you ſtill urge this queſtion ſo prepoſterouſly, and ſo wide of the purpoſe? From the very beginning you muſt know the cauſe of *gravity* at all events: now you are ſolicitous to know *what cauſe* ſo conſtantly impreſſes this force on the planets. You ſee a prodigious force is neceſſary; you ſee this prodigious force is ſupplied, and juſtly impreſſed for attaining the end: and is it not very happy for us that things are ſo? That *power* and *force* are not wanting in nature, to our comfortable ſubſiſting; though we ſhould neither know *how* nor *whence* they are ſupplied?

M. Why did you not tell me from the beginning then, *Are we not very happy that all things are ſo as we ſee them, though we ſhould know nothing farther about them?* There would be a compend of knowledge indeed, and an end of enquiry! Have you not told me that nothing is ſo pleaſant to the rational nature as the diſcovery of truth; nothing more generous than to communicate knowledge? Is it generous or fair, Philon, firſt to raiſe in me a rational deſire, and then to ſeem to envy me the gratification of it?

P. That is not the caſe, I can aſſure you, Matho: but ſince you are ſo importunate, we ſhall come to the *cauſe* immediately; though the longer it

it had been delayed, it muſt have been diſcovered with the greater certainty; for which reaſon I was willing to put it off for ſome time.

M. As you have encouraged me to oppoſe and contradict you, you need not fear I ſhould give my aſſent till I were fully convinced of the truth of what you advance.

P. To come to the point then.

XLVII. Tell me, do you remember an obſervation you made before, when we were ſpeaking of the figure of the cœleſtial bodies, from which you inferred that they were all ſpherical?

M. What was it?

P. It was that this attraction, which obtains through the whole maſs of our earth, and belongs to every particle of it, is no leſs prevalent in all the other bodies of the univerſe.

M. I remember it very well, and am ſtill of the ſame mind, ſince that mutual tendency, of all the parts of any body to each other, muſt naturally bring them into a ſpherical figure. It is not enough that they come into contact *any how*, ſo as to form an irregular figure: they muſt ſtill move to that point where the ſtronger force draws them; and thereby form, and tend to a center. In fluids this is very plain, let the body be a hundred or a thouſand times as big as our earth, as you then ſhewed me. And in this caſe we muſt diſtinguiſh, I conceive, between the two ſorts of attraction, that of *gravitation*, and that of *coheſion*. They are quite different forces, and preſerved diſtinct in their effects, even when they tend the ſame way, as you then likewiſe explained. It is thus the particles of iron, which tend to the center of the earth, adhere to other particles of the metal in the

the ſame direction, by a different ſort of force: the two forces, you ſaid, could not have been preſerved more diſtinct, though the particles had been large enough to admit of pulleys and engines to be faſtened to them, and though they had been wrought by the moſt ſkilful hands. In ſhort, as gravitation is a tendency of every particle of matter to be in contact with every other poſſible particle, this could never form a *tough*, a *hard*, or a *brittle* body: therefore it leaves matter ſtill in the leaſt poſſible ſeparate particles, without any particular degree of coheſion between neighbouring particles. It only regards the figure of the whole maſs, and as it effects no particular coheſion between parts in contact, it muſt neceſſarily produce roundneſs of figure in every body great or ſmall: and wherever it is otherwiſe, the effect muſt be hindered by the different degrees of coheſion in particular bodies; as you ſhewed me it was in the mountains, which are ſupported by hard and unyielding rocks, that they may keep to that height ſo neceſſary to a habitable globe.—You likewiſe ſhewed me in the moſt convincing manner, that the ſame attraction of gravitation is indiſpenſibly neceſſary to preſerve the great bodies of the univerſe in that ſpherical figure. Without this, water would not be water, nor could fluid bodies conform themſelves to a globular ſurface, as we ſee they conſtantly do. They might admit of, or remain in any ſort of figure, how wild or irregular ſoever; or if any force detached them, they might remain in the ambient ſpace, without ſeeking back again to their proper center. Nay, all matter might thus remain ſcattered and diſſipated in the wide expanſe.—From theſe conſiderations, this attraction of gravitation ſeems to

me

me the only power in nature, adapted to form matter into ſpherical bodies; and the neceſſary *cement*, without which they could not be preſerved in that figure; and therefore we muſt ſuppoſe that it firſt obtained, and ſtill prevails, through all the ſtars of heaven, as well as between all the particles of our earth, or of the other planetary bodies, which we know to be prodigious ſpheres of matter.

P. I find, Matho, you are not idle when abſent: you have greatly improved the ſlender hints I gave you. Nothing can be more juſtly obſerved, than that the attraction of gravitation, ſince it is a tendency of every particle to be in contact with every other poſſible particle, can effect no particular degree of coheſion between the particles in contact. Hence this attraction leaves, as you ſaid, the leaſt poſſible parts of matter looſe and ſeparate among themſelves, ſo as to move eaſily one upon another, provided their diſtance, with reſpect to the center of their tendency, be not changed. We cannot conceive that from this, or from any other uniform impreſſion on the ſubſtance of matter, there ſhould ariſe a *diverſity*, or *irregularity* of figures among the particles, to hinder their eaſy motion, or ſliding one upon another. *Irregularity of figure* proceeds from different degrees of force, variouſly impreſſed (or different degrees of coheſion) in order to conſtitute different ſorts of bodies. Thus this attraction, as you rightly inferred, only regards the figure of the whole maſs; and that one uniform and regular figure, to wit, the *ſpherical:* whereas the other ſort of attraction is conſiſtent with any ſort of figure, how irregular ſoever. And thus we may be ſatisfied that any quantity of matter in theſe circumſtances (that is, the moſt fluid poſſible) muſt form

form one great body perfectly ſpherical. We muſt likewiſe conceive (according to the order of nature) that this ſort of impreſſion was firſt made upon matter; and that the particular attractions, which conſtitute the different degrees of coheſion, and form the various ſpecies of bodies, were ſuperinduced upon it. It was certainly neceſſary, before the particular ſorts of bodies could be formed out of the common maſs, that the particles ſhould all be brought to one place. And accordingly all the particles of the ſeveral kinds of bodies which we know, were once in a fluid form; the bodies themſelves therefore were formed out of matter under theſe circumſtances.

M. This natural deduction even aſſiſts the imagination; and the reaſons aſſigned ſhew to ſatisfaction, that this attraction firſt formed (as I ſaid before) and ſtill preſerves the ſpherical figure of all the ſtars in heaven, as well as of all the bodies in our ſolar ſyſtem.

P. I am glad you are ſo much maſter of this ſubject: you could not have recollected theſe particulars, and reaſoned upon them thus at a more proper time; nor can any thing be of more ſervice to you in the enquiry we are upon at preſent. Wherefore tell me, Matho, do you think that this attraction of gravitation, by which theſe bodies ſtill preſerve their ſpherical figure, obtains or acts only within their ſurfaces?

M. This queſtion, after what has been ſaid, I ſhould think, cannot be difficult: however, let me conſider it, that I may be able to give ſuch an anſwer as may be ſatisfactory to us both.

XLVIII. Toward the center of every great body is *downward* with reſpect to it; from that center

center is *upward:* this only happens becauſe of the attraction or tendency to that center from the ambient ſpace. It is certainly ſo round our earth: the falling of rain from the clouds, and the deſcent of heavy bodies projected upward, plainly ſhew it. If bodies thrown upward were not retracted, the force of the projection being ſpent, they would remain ſuſpended on high: or rather, if there were no retraction, the force of the projection could never be ſpent. It muſt be ſo every where elſe, I conceive, otherwiſe attraction could be of no uſe to preſerve the ſpherical figure of thoſe great bodies: any part detached from them would remain for ever afterward ſeparate. If theſe ſpherical bodies were formed by attraction at firſt, as we have juſt now ſeen they were, it muſt have been by the ſeparate particles tending to each other from all the ſurrounding ſpaces. Why ſhould not the ſame attraction prevail ſtill, or be able to act through all the ſame ſpaces? Matter cannot be leſs *attracting matter* now, than it was then. If there were any quantity of matter through the whole ſolar ſyſtem, which was attracted to no center, it would remain there uſeleſs and unemployed. This ſhocks the notion we have of the order of things. It might intercept the light of the ſun and ſtars, and make a darkneſs and confuſion in our ſyſtem. Such a world as ours requires tranſparency and clearneſs: upon this our comfort, our heat and light depend. How is tranſparency effected? A ſmall quantity of vapours, we find obſtructs it. Our atmoſphere is kept pure by the repellency of its parts; and yet, through all its height, it is attracted to the earth. ——Theſe, Philon, are the thoughts which occur to me on this ſubject, with regard to the ſeveral particulars

particulars we have diſcourſed upon before: and they ſeem to ſhew that attraction acts all around, without the ſurfaces of the great bodies of nature.

P. You have touched upon ſome things, Matho, of no ſmall conſequence: our atmoſphere is a ſcene of peculiar wonders. But leaving theſe, you are really of opinion then, that there is no ſpace within the ſolar ſyſtem, where attraction to ſome center does not prevail?

M. I am: for this attraction does not (like the other) act in contact only, but at vaſt diſtances; of which we have certain proofs.

P. What proofs?

M. No body can be ſo big, ſince all the parts of matter in it attract each other, but that many particles muſt attract one another at the whole diſtance of its diameter.

P. But theſe extreme particles may attract each other, by means of the intermediate particles.

M. Since attraction between any two particles is not, properly ſpeaking, the effect of matter at all, it cannot be the effect of *intermediate matter:* and the two particles muſt affect each other the ſame way, whether any other particles lie between them, or not. At this rate then, ſince, abſolutely ſpeaking, it is poſſible that a body might be ſo big as to fill the whole ſolar ſyſtem, we ſee that two particles of matter muſt actually attract each other at all that diſtance.

P. It is ſo indeed.

M. Therefore attraction not only *may*, but *muſt* act through all that ſpace. If we ſuppoſe the contrary, great diſorders muſt enſue. If our earth, for inſtance, came to a place where attraction to no center prevailed, it is hard to imagine what would be the conſequence.

P. It

P. It would ſtill attract bodies to its own center, even in ſuch a place.

M. That is true; but being thus deſerted, it would remain there, like a piece of uſeleſs lumber: or, if the projectile force ſtill acted, it muſt, at leaſt, ramble out for ever through the ſpaces on high.

P. What do you ſay, Matho; would the earth be *deſerted*, or at leaſt *ramble out for ever*, if it came to a place where attraction to no center prevailed? Stop a little, and conſider well the conſequences of what you are ſaying.——

M. This is an agreeable ſurprize, Philon! You have brought me to maintain, without my knowing it, the thing I chiefly wanted to be informed in. This attraction of gravitation acts indeed through the whole ſyſtem, and is that *mighty force*, which conſtantly impels the earth, and all the planets, towards the ſun, the center of their motion; and, together with their projectile force, maintains their revolution. It appears to me now ſo natural, that if there were any place throughout the ſyſtem where attraction did not obtain, that would be the region of diſorder and confuſion. It is not only the preſervative of particular bodies, but the cement of the whole planetary world, and I believe, of the whole univerſe: for confuſion and diſorder of uſeleſs and unemployed matter can reign no where in nature. This likewiſe is that *centripetal force*, I ſuppoſe, by which our moon and the other ſecondary planets are retained in their orbits about their primaries; there being attraction to the centers of thoſe *great bodies*, as well as to that of the ſun.

P. That you may affirm without heſitation: every thing is alike, you perceive, in both caſes;

to

o the centers of theſe planets is *downward*, from a conſiderable ſpace round them; and the ſecondary planets obſerve the ſame beautiful proportion in rolling about them, as they obſerve in rolling about the ſun himſelf.

M. That, namely, between the ſquares of their periodical times, and the cubes of their diſtances?

P. The ſame.

M. Well, Philon, when ſhall I underſtand this proportion?

P. Not the ſooner for your impatience.

M. That is true: however, I now perceive the other reaſon *why the ſun was to be ſo large a body*, with reſpect to the reſt of the planets, which you before kindly left to my own diſcovery.

P. Namely?

M. Not only the heat and light of the ſun were to be diffuſed all around, as far as the orbit of Saturn, but his attractive force was vaſtly to exceed that of all the planets, that he might not be drawn from the center of the ſyſtem. I am ſatisfied I ſhould not have had half the pleaſure, if you had told me this, that I now have in finding it out myſelf.

P. For what muſt have happened, if one of the leaſt, inſtead of the greateſt body, had been placed in the center of the ſyſtem?

M. It could not at all have been a ſyſtem, if the central body had not force enough to reſiſt the attraction of the other revolving bodies; but muſt inſtantly have gone into diſorder, and been carried through the cœleſtial regions with endleſs confuſion. It is as if we ſhould ſuppoſe a *mill-ſtone* to revolve about ſome *little pebble*, and not the pebble about the mill-ſtone.

P. This reaſon, Matho, is according to the nature of things: or, if I might ſo ſay, the voice of nature itſelf.

M. And from this view of the ſyſtem, I perceive it muſt, indeed, be either ignorance, or obſtinacy, to contend that the earth is in the center, and that ſuch a body as the ſun ſhould revolve about it. In that caſe the earth would ſoon be dragged from its place, and, together with the reſt of the planets, follow him through unknown parts, towards the fixt ſtars.

P. You touch upon an univerſal and concluſive reaſon, for placing the ſun in the center. All the ancient aſtronomers (Pythagoras excepted) and ſome of the moderns likewiſe, in ſettling the order of the planetary ſyſtem, determined themſelves only by optical appearances (concerning which we ſpoke before) without any regard to phyſical conſiderations; though the centrifugal force of bodies is inſeparable from their moving in circular, or, indeed, any other ſort of orbits.

M. I thought no other order of the ſyſtem had been pretended, than the Ptolemean and the Pythagorean.

P. Tycho Brahe, a noble Dane, obſerving that Venus and Mercury never appear on the ſide of the earth oppoſite to the ſun, contrived a mixt ſort of a ſyſtem, where Venus and Mercury revolve, it is true, immediately about the ſun; but he, with theſe two planets, revolves about the earth in the center.

M. That does not mend the matter, with reſpect to the centrifugal force of ſuch a mighty body as the ſun, revolving about ſuch a ſmall body as our earth: and even thus, I preſume, he could not account very naturally for the retrograde motion

tion of the ſuperior planets, Mars, Jupiter, and Saturn.

P. He could not.

M. From this I perceive more fully than before, that placing the ſun in the center, is the only thing that can ſatisfy both optical appearances, and phyſical reaſons.

P. That alone is the order, with which a fair enquirer can reſt ſatisfied. ——

M. I now likewiſe perceive why, in giving me the order of the planets, you reckoned it *upwards* from the ſun to Saturn: for though it be *downward* to the center of every particular planet from the utmoſt extent of the ſphere of its attraction; yet ſince the ſun's attractive power is predominant over the whole ſyſtem, the *upward* and *downward*, with reſpect to him, muſt extend to its utmoſt limits.

P. And a great deal farther too.

M. It is ſomewhat unnatural to ſuppoſe it to end all at once, and at a certain limit; it muſt rather grow weaker and weaker by degrees: but pray how much higher does it reach?

P. You muſt be content to be ignorant of that at preſent.

M. Another difficulty then occurs to me on this ſubject: if the ſun's attraction be predominant over the whole ſyſtem, and at the ſame time every planet retains a ſphere of attraction peculiar to itſelf, or where its force is predominant, how is it that theſe contrary actions do not diſturb each other?

P. That is not a point to be diſcuſſed eaſily, or in few words.

M. I think I could manage it by myſelf.

P. You will certainly underſtand it better, if you try it beforehand.

M. In the mean time then let us go on with the ſubject we were upon before.

XLIX. *P.* You have now diſcovered *one* of the forces, by which the planets are governed in their orbits round the ſun.

M. I have, with much pleaſure; and could almoſt gueſs at the *cauſe* which impreſſes this force ſo powerfully, ſo juſtly, and at ſuch various diſtances: though I am not yet quite certain.

P. It is ſomething to know the nature of the force itſelf, that it is the ſame which you firſt admired in the fall of a ſtone: for it could be ſhewn by an eaſy computation, that if a ſtone were removed to the diſtance of the moon from the earth, it would fall juſt as far in a minute, by the force of gravitation, as the moon is attracted from her projectile direction in the ſame time. And ſince (as I mentioned juſt now) the ſame proportion obtains in the motion of the ſatellites about their primaries, and of the primary planets themſelves about the ſun, we may be certain that the attraction, which prevails through the whole ſyſtem, is the ſame by which a ſtone, when thrown up, falls down again to the earth.

M. I underſtand: you argue from the ſtone to the moon; from the moon to the reſt of the ſecondary planets; and from the ſecondary planets, to the *primary*; ſhewing the force ſtill to be of the ſame kind. So that a ſtone gravitates to the earth, and the earth itſelf to the ſun, by the ſame ſort of action.

P. It is ſo: as to the cauſe both of this and the projectile force, it will in a little time become plain.

plain. But that you may the better conceive the uſe and nature of the projectile force, anſwer me again a few queſtions.

M. I am ready, as far as common ſenſe can ſuggeſt to me.

P. If *the attractive force* only prevailed in the ſyſtem, what conſequence would it have?

M. The ſun, as I ſaid before, would draw down all the planets to himſelf, where they would remain ſtrongly attracted to his body, without any farther motion or order.

P. Which event, Matho, would be the final deſtruction of both the animal and vegetable nature, in the whole ſyſtem; the earth, and all the other planets, being conſumed, or quite diſſipated by his raging fire.

M. Dreadful cataſtrophe! But ſuch an ocean of fire was neceſſary, to make our planetary world habitable.

P. How could this horrible confuſion have been prevented?

M. It could only have been prevented by a MIGHTY HAND impreſſing on the planets the other force, the projectile, to wit, by which they tend to move on in ſtraight lines; that by a compoſition of both forces they might deſcribe circular orbits round this ocean of fire and light.

P. Could this force impreſſed *any how*, and *at a venture*, have had that effect?

M. Let me conſider a little——It could not: the quantity of this force was to be juſtly attempered to the ſun's attraction, that it might neither be too weak, nor too ſtrong; but keep the planets always at the ſame diſtance. And then this juſt quantity of the projectile force was ſkilfully to be *directed, for avoiding* an equal inconvenience.

Had the direction been oblique, either *from*, or *to* the ſun, the planets could not have moved in circular orbits: ſome of them might have aſcended without the limits of the ſyſtem, and others been carried down towards the ſun in the center.

P. You are ſatisfied then that *art* and *ſkill* were to be employed in this matter?

M. Fully.

P. And that doing things at a venture might have miſſed of the effect?

M. It is rather impoſſible that doing things at a venture could have reached the effect, as there is but one way of hitting the mark, and ten thouſand different ways of miſſing it: and that, whether we conſider the adjuſting the projectile to the attractive force in any one body, or giving it the proper direction when adjuſted. And much greater is the difficulty, if we take into the conſideration all the bodies of the ſyſtem.

P. What you ſay is very true, Matho; for as the ſun's attractive force on every one of the planets is different, ſo the projectile force was to be different in each of them: and the ſame attempering the two different forces, with the propriety of direction, was no leſs neceſſary in the motions of the ſecondary planets.——Now conſidering theſe two forces *conſtant y* impreſſed, and alſo the attraction of coheſion if you pleaſe, you are ſatisfied that theſe are not the actions of matter itſelf?

M. I am, for reaſons which I have often repeated. A particle of matter cannot act ten thouſand different ways at once, and at immenſe diſtances. Nothing can act where it is not. This ſatisfies me as to the attraction of gravitation, that it is not the action of matter. As to coheſion, if there

there were nothing to be overcome but the inactivity or inertia of matter, that force, which moves and overcomes the reſiſtance of the whole body, muſt certainly overcome the reſiſtance of a ſmall particle of it, or ſeparate that from the reſt; which yet conſtant experience ſhews to be otherwiſe. Though this attraction be only between contiguous particles, and does not reach to diſtant parts; ſince a large bar of iron is not more hard and firm than a ſmaller piece; yet we can by no effort ſeparate thoſe leaſt parts, or counteract that force wherewith they adhere to each other. Hence it is manifeſt that this can leſs be the effect of theſe little particles, than gravitation itſelf. As to the impreſſion of the projectile force in the motion of the planets round the ſun, it was this which from the beginning I ſaw as much required an external cauſe, as the ſtone in the ſling; or rather infinitely more. It would be ridiculous to ſuppoſe that a ſingle *mountain*, or but a *rock*, might of itſelf ſhoot through the ether, at the rate of a thouſand miles a minute, or even of a hundred; beſides giving itſelf a conſtant change of direction.

P. From this you muſt allow, that theſe actions proceed from the power of an IMMATERIAL CAUSE.

M. That was the eaſy diſtinction I gave at firſt; if any thing is not effected by matter, it muſt be effected by ſomething *not matter*.

P. All the power therefore, which we ſee exerted in the material univerſe, muſt proceed from an *immaterial cauſe*.

M. The connexion between this propoſition and the laſt is ſo ſtrong, that they ſeem but one and the ſame thing. If matter can do no-

thing, all material nature muſt conſtantly be influenced, and acted upon by *this cauſe*.

P. This cauſe likewiſe muſt not only be poſſeſſed of all the power we find exerted in the material world, but alſo be *knowing* and *ſkilful*.

M. A cauſe, which works with intelligence and ſkill, muſt be a *knowing* and *ſkilful cauſe*.

P. Does this cauſe only exert its power by ſtarts, and in ſome places, or always and every where?

M. The effects we have ſeen are *inceſſantly* produced through *all* nature;——and to ſave you the trouble of more queſtions, Philon, the point is now become too plain, for any perſon not to know that this cauſe is the *all-powerful* and *infinitely perfect Being*. I had the Deity in my thoughts ſome time ago, but imagined you were to tell me of ſome ſecret and unknown power in *nature*, which performed all theſe things; which I believe is the common way of thinking with regard to this ſubject. There is hardly any one who would allow that the weight of a ſtone, or the hardneſs of iron, were effects which required the conſtant action of the Deity.

P. It is too much the common way of thinking, Matho, even among thoſe who ought to think otherwiſe. If I might complain of the abuſe to you (whom I would wiſh to have quite a different way of thinking) it is accounted the great perfection of philoſophy, never to come to the *firſt cauſe* (that is reckoned mean and inartificial) but to hunt after *ſecret* and *hidden cauſes*, and ſo to explain the frame of nature, as if it were ſome way or other independent and ſelf-ſufficient.

L. On the contrary, we muſt ſoon, very ſoon, come

come to the *firſt cauſe*, if we would reaſon right. It is wiſely and kindly ſo ordered that we ſhould eaſily diſcover that *cauſe*, which is the *end* and the *reward* of all rational enquiry. What does all my ſtudy ſignify, if at ſumming up the account, and after an application of many years, it leaves me in doubt whether I be the production of *chance*, without any deſign, or the work of an *infinitely wiſe and good Being:* whether I be deſigned for an endleſs duration, or ſoon to drop into non-exiſtence? Application, without this view, ends in the moſt dreadful uncertainty about ourſelves. It was for this purpoſe only that the rational powers of the ſoul were given us; that we might diſcover the *Creator* in the works of nature. Had we nothing more to regard than the brutes, the *back* and *belly* only, and the ſenſitive part of our nature, we ſhould have had no higher faculties than they.——But having once diſcovered the *firſt cauſe*, which (as I have ſaid) we may eaſily do; we may then go on with pleaſure and ſecurity: we may then indulge our reſearches into the works of nature to the laſt; and with greater alacrity, as being certain that in every ſtep we advance, we make a new diſcovery of the power and wiſdom of the author of nature. It is true, we muſt ſoon be loſt amidſt the ſubtlety of work, and niceneſs of contrivance: for a ſmall knowledge of the art and power of the Creator is the height of all human attainments here: but even this is pleaſant and comfortable; we know by whom it is we are ſurpaſſed. Whereas, if once we paſs by the obvious appearances of nature, endeavouring to find the cauſes of theſe in more hidden operations; and the cauſe of thoſe again, in things ſtill more abſtruſe; and ſo at length to

come to the *firſt mover* in this method; we are under a grievous miſtake. It is as if we ſuppoſed our faculties, which are over-powered with the ſubtlety of nature's operations in the ſecond ſtep, were able to determine with more clearneſs and certainty, after they are got down among the inſcrutable *fineſſes* of the work. The Deity hath not left himſelf thus to be diſcovered; but hath kindly brought the ſtrongeſt degree of evidence, even within the reach of the methods of ſenſe aſſiſted by reaſon.

M. You ſeem to ſpeak with ſome concern, Philon: but I perfectly conceive the reaſonableneſs of what you ſay. Bad indeed would it be for mankind, if men of leiſure and genius only could diſcover from the material world, that there was a Deity; and that the heavenly motions, and the whole frame of nature, are ſtill kept in repair by his power. Such neceſſary knowledge was intended to be eaſily attainable.

P. This, Matho, was the original knowledge of men in their firſt ſtate. But as diſputes have been raiſed, and thoſe are ſuppoſed to underſtand things beſt, who ſeem to ſpeak with doubt and heſitation (this having a ſhew of greater knowledge;) I would willingly have put off the concluſion we are now come to for ſome time, till we had conſidered the nature of matter more carefully, and thereby left leſs ground for doubting.

M. And for all that I think we have not been raſh, nor concluded any thing haſtily, or from one reaſon only: I even fancy I could, in a plain and rude way, ſatisfy another perſon, who was deſirous to be informed about theſe things; though perhaps I could not deal with an unfair and captious adverſary. However, nothing hinders us

from

from going on with the conſideration of matter ſtill: this is agreeable to your own method; we ſhall go forward with the greater alacrity, as being certain that in every ſtep we advance, we ſhall make a nearer diſcovery of the power and wiſdom of the *Author of nature.*——I began to think, that the reaſon why you kept me ſo long on the examination of things, before we came to this concluſion, was, that I might have ſome previous conception of the power and wiſdom of the Deity, from the greatneſs of the effects he conſtantly produces: for I find I could not have had ſo full a notion of theſe, by being ſimply told, *his perfections were infinite.*

P. That had been a very juſtifiable reaſon, Matho, if I had had it in my view. It is eaſy to pronounce theſe words, *A being of infinite perfections*, and other expreſſions of this kind; but we frequently uſe them rather as words of courſe, mere technical terms, when we ſpeak of the Deity, than as having any tolerable notion of what they import. Nor is it eaſy for ſuch creatures as we are, whoſe firſt information of things is from ſenſe, to have ſo ſtrong and lively a conception of infinite power and knowledge any other way, as by contemplating the effects of theſe pefections in the viſible creation.

M. I am convinced that the method we have taken was the beſt we could have taken.——But what ground for doubting have we left?

P. None, I think, to a fair enquirer: but you muſt not expect always to meet with ſuch. For ſome have denied that the fabrick of the univerſe owes its origin to wiſdom and deſign, or is governed by power and knowledge.

M. Muſt not ſuch an artful contrivance of

this frame, and nice adjuſtment of one thing to another, have proceeded from reaſon and deſign?

P. They deny it did.

M. What ſort of effects are thoſe then, which reaſon and deſign produce, according to theſe men?

P. No ſort of effects at all.

M. How can they who deny this, ſhew that they themſelves are reaſonable beings?

P. By endeavouring to overturn your reaſons.

M. Can they ſhew ſuch ſtrong marks of reaſon in this attempt, as thoſe are which they deny to be marks of reaſon in the works of nature?

P. They themſelves muſt look to that.

M. Do they know all the inſtances of art in the works of nature?

P. No man on earth can pretend to know them, in reſpect of any one particular: all is art till our faculties fail in the inveſtigation.

M. They cannot therefore be judges of what they do not underſtand. I remember what you ſaid, when we were ſpeaking of the uſefulneſs and neceſſity of mountains on our globe. Ignorance only can make a man find fault with the contrivance and beauty of the univerſe.

P. There is a pretty famous ſtory told to this purpoſe, Matho, of a certain king, who, not underſtanding the order of the planetary ſyſtem, ſaid, had God conſulted him about the contrivance, he could have ſhewn how it might have been mended *.

M. Poor mortal!——As to the power diſcovered in the motions of the heavenly bodies, do

*——*Il oſa dire* [*Alfonſe dixiéme roy de Leon*] *que ſi Dieu lui eût fait l'honneur de l'y appeller, il lui auroit donné des bons conſeils.* Moreri in Alfonſe.

theſe

these men contend that the conſtant retraction of the planets towards the ſun, contrary to the tendency of bodies revolving about a center, proceeds from nothing? Do they ſay that the firſt impreſſion of the projectile force on ſo many prodigious globes of ſluggiſh matter, and the exact adjuſtment of that force to balance the conſtant centripetal tendency, required neither power nor art in the *cauſe?*

P. They aſcribe all thoſe things to matter itſelf.

M. Do they aſcribe to matter thoſe things, the performing of which it ſtruggles againſt? Matter at reſt, ſtruggles againſt being put in motion; when in motion, it ſtruggles that it may not be turned out of its direction ſtraight forward; and therefore it cannot perform that, the performance of which it reſiſts. What do they ſay to this?

P. I do not really know.

M. Could you anſwer any thing for them?

P. Nothing, indeed, if I ſpeak ſenſe: perhaps they may ſay, that matter does not reſiſt neceſſarily, and of itſelf, to be put in motion, or turned out of a ſtraight direction, when moving.

M. Another cauſe then, different from matter, muſt be neceſſary, by whoſe aſſiſtance matter might reſiſt; and it would be extremely fooliſh in them, to deny a cauſe different from matter, and yet have recourſe to *a cauſe different from matter.*

LI. *P.* Now ſtop a little, Matho, and conſider what you have done. You will find that you have concluded more in few words, than I could have ſhewn you by many arguments.

M. You will make me vain.

P. Nothing like it: for from the reſiſtance of

matter, you have ſhewn the *abſolute neceſſity* of an immaterial cauſe, let an adverſary ſay what he will, or be ever ſo unfair and captious. If matter neceſſarily reſiſts a change of ſtate, whether of reſt, or moving uniformly forward, an *immaterial cauſe* muſt be neceſſary to overcome its reſiſtance: if it doth not of itſelf, and neceſſarily reſiſt, an *immaterial cauſe* muſt ſtill be neceſſary, by whoſe aſſiſtance it may reſiſt.

M. I ſee in either caſe, the ſluggiſhneſs or *inertia* of matter appears undeniable: for if matter neceſſarily reſiſts a change of motion, or of reſt, it cannot effect that which it reſiſts: and if it reſiſts only by the help of another cauſe, it can as little produce the effect as before, nor even reſiſt producing it, without aſſiſtance from ſomething elſe. This is making it the moſt impotent thing we can have any notion of.

P. We could not form a notion of any thing ſo ſluggiſh and impotent, and that on every ſuppoſition, unleſs from this very ſubſtance. So ſluggiſh, that you may defy the fierceſt *ſceptic* to doubt of its inactivity. The inertia of matter is one of thoſe things, which, by being doubted of, forces the mind to aſſent the contrary way.

M. Yet from this two-fold notion of the inertia of matter, I perceive that it muſt be good for ſomething, on the firſt ſuppoſition; namely, that it neceſſarily reſiſted all change of its ſtate of reſt or motion: but on the laſt ſuppoſition, viz. that it made no reſiſtance to a change of its preſent ſtate, it would be utterly unfit for any purpoſe in nature.

P. Pray ſhew me by ſome example, on what ground you make this obſervation.

M. If a body did not reſiſt to be brought to

reſt,

reſt, when it is in motion, it could have no force, nor produce any effect. When a cannon-ball is diſcharged againſt the wall of a town, if it made no reſiſtance to a change of its ſtate of motion, it might be ſtopt by the leaſt force, and would not ſignify ſo much as a puff of air.

P. Be a little more particular; would it require any force at all, leſs or more, to ſtop it?

M. I mean, it would require no force; otherwiſe it muſt make ſome reſiſtance, contrary to the ſuppoſition.

P. Then all the force, or effect, which a body in motion has on any other body, proceeds from its reſiſtance to change its preſent ſtate?

M. That is, indeed, my meaning.——And again, if a body made no reſiſtance to be put in motion, the greateſt body, a *houſe*, a *rock*, a *mountain*, or the *whole earth*, might be moved with the leaſt force, or rather with no force, ſince it could make no reſiſtance to be moved with any poſſible celerity.

P. Might not the mutual coheſion of parts in a *rock*, keep it fixt, and immoveable?

M. If they kept the rock firm in itſelf, the earth and all muſt be carried along, ſince nothing could make reſiſtance. But why ſhould the parts cohere at all? This would be only reſiſtance to change their ſtate of reſt among themſelves.

P. That is very true: go on.——

M. Where would this end then; or what conſiſtent conſequence could it have? If a body in motion came up upon another body at reſt, the firſt might be ſtopt by no force, the ſecond might be moved by no force, ſince neither could make any reſiſtance to a change of its preſent ſtate. Whereupon I aſk you this queſtion, *Whether would they both move on, or both reſt?*

P. I cannot anſwer it.

M. If the firſt body were ſtopt, motion is taken off by nothing; if the ſecond moved along, motion is excited by nothing. This makes motion to be *nothing*. A thing produced by no cauſe, and put an end to by no cauſe, muſt be *nothing*, if language could expreſs ſuch contradictory notions.

P. I agree with you, Matho; the motion of ſuch unreſiſting matter (if ſuch motion be not contradictory) muſt be as ineffectual in nature, and therefore as uſeleſs as reſt. Whatever effect is produced by matter, is produced by *reſiſting matter*. The particles of light, which are reckoned the moſt ſubtle and active, are yet *reſiſting matter*; as we may experience by the heat and motion they produce in bodies. The atheiſt therefore, by taking away the reſiſtance of matter, muſt take away the uſe both of matter and motion in the world; by which notwithſtanding he would have all things to be performed, and produced, without the help of a Deity.

M. This ſuppoſition alſo takes away, I think, the nature of matter itſelf: otherwiſe, I would aſk this queſtion; If two equal bodies, moving with equal celerity, ſhould meet one another, what muſt the conſequence of their meeting be? Could there be any *ſhock* between them? Would they ſtop on coming to contact; or could they bear a touch?

P. There could be no ſhock between them; nor do I ſee that they could bear a touch, ſince that would ſhew reſiſtance to a change of their ſtate of motion.

M. This makes body then a mere ſhadow, and nothing ſubſtantial.

P. You

P. You are certainly in the right, Matho: matter that could *communicate* no force, could *bear* no force; and matter that could *bear* no force, would not be ſolid ſubſtance, but only the phantom or ſhadow of matter: which concluſion of yours will alſo appear thus. Unreſiſting matter could not *communicate* force, nor *bear* force; nor therefore *withſtand* that conſtant impreſſion which it receives in coheſion.

M. I have ſome notion of this; but pray ſhew me how it is, for I am too impatient to think about it?

P. Suppoſe a weight ſuſpended by a wire of metal, ſo great, that the wire could ſupport no more without breaking. The parts in the thickneſs of this thread of metal, through its whole length, by their firm coheſion, reſiſt the whole force of thirty, or forty, or fifty pound weight perhaps, according to the thickneſs of the wire: for if in any part the reſiſtance were leſs, or the coheſion leſs ſtrong, the wire muſt break there, and the weight fall down.

M. I take it.

P. But the coheſion of its parts is not ſtronger now, than when the wire ſupports no weight.

M. Certainly it is not; for the weight doth not increaſe the ſtrength of the wire, but only tries it.

P. Every part then in thickneſs of this wire adheres to the contiguous part, by a conſtant impreſſion, equal in force to the greateſt weight it could ſuſpend without breaking.

M. I ſee it plainly. Hence it is equally pleaſing and wonderful, to conſider the ſtrong impreſſion which firm bodies conſtantly ſuſtain in all their parts: and ſurely if matter could bear no force,

it

it could not ſuſtain this conſtant impreſſion, nor be ſolid ſubſtance; but yielding to the force, or rather before the force (for it is difficult to expreſs the caſe conſiſtently) be at laſt reduced to nothing. I perceive the anſwer I gave you, with reſpect to the coheſion of the parts of the rock, was right: if it were unreſiſting matter (I mean if that did not imply a contradiction) its parts could not bear the force of the impreſſion in coheſion, nor the force of its own gravity to the earth; that is, it could have no gravity; nor therefore could they make any reſiſtance to be moved. And the argument is the ſame in every part of matter, between whoſe particles there is any degree of coheſion; and that is, I think, in all matter.

P. You touch upon another particular, Matho, concerning the gravity of the rock, which ſhews us the ſame truth univerſally. If matter could bear no force, it could not gravitate to a center, nor be weighty; ſince weight, or tendency to a center, you know, ſuppoſes force impreſſed.

M. I remember it. A body gravitates no leſs, when ſuſpended in a balance, or while it is in the air, than when it lies on the ground. And matter bears this impreſſion, though it is not in contact with the body to which it tends; otherwiſe it would tend to that body with no force, or, not tend to it. This, I perceive, would diſſolve the cement that keeps together the material univerſe; for *attractive* force, *centrifugal* force, *projectile* force, would be then impoſſible.

P. This alſo is no leſs true in the *repulſe*, than in the *attraction* of matter. When we endeavour to compreſs the particles of air, they bear a prodigious force, without coming into contact: and the under parts of the atmoſphere ſtill ſupport, after this

manner,

manner, the incumbent weight of the upper parts. In ſhort, as it is by reſiſtance that the parts of all bodies, whether *animal*, *vegetable*, or *unvegetating*, act upon one another in all natural operations; and as it is by reſiſtance that they could either communicate force, or bear force; unreſiſting matter would not only be of no uſe in the world, but is a contradictory notion; ſince the leaſt force, or rather, indeed, no force at all, might then conſume and quite annihilate all the matter in the univerſe.

M. I underſtand it fully: this notion of unreſiſting matter deſtroys the ſubſtance in all ſenſes.

LII. And now, Philon, from this nearer view of matter, I ſee, with pleaſure, that it muſt neceſſarily reſiſt all change of ſtate, as it is a ſolid and impenetrable ſubſtance: and if we do not conceive it as reſiſting a change of ſtate, we cannot conceive it as ſolid and impenetrable; nor in truth have any conception of it at all.

P. Since this is ſo, I hope you are now ſatisfied of a point, which from the beginning you allowed to be extremely probable.

M. What was it?

P. That *change of place*, *tendency* to any ſide, *motion* of any ſort, or *change of direction* when in motion, does not belong to matter, or body.

M. I am ſo much the more ſatisfied, that matter can effect none of theſe changes in itſelf, as it requires a poſitive force to be impreſſed upon it, in order to overcome the reſiſtance it makes to the change.

P. And if it required no force to be impreſſed upon it, or had not this ſtubborn inactivity?

M. Then it could be of no uſe; or it would

only

only be the phantom of ſolidity, and not real body; more than the ſhadow of a houſe is a houſe, or the picture of a tree is a real plant.——And this is what I moſt admire, Philon, that the very *deadneſs* of matter, or its reſiſtance to the performance of any effect, ſhould be made the means of its doing all that it performs. This ſeems to me the ſtrongeſt proof of a *living* and *immaterial power*, conſtantly working in all nature, and actuating this ſubſtance, that the heart of man can conceive or deſire.

P. We ſhall therefore reaſon for the future concerning this ſubſtance, with more ſecurity, and leſs fear of making falſe concluſions.——But have you a notion of any power beſides a *living* and *immaterial power?*

M. Since what matter *does*, is only by *reſiſting to do*, there is no power beſides *immaterial power:* and no man can have a notion of what is not. As to *dead power*, it is a direct repugnancy.

P. Can there be power in nature, without a *powerful being* to whom it may belong?

M. Every perfection, as I apprehend, muſt be the perfection of *ſome being:* a perfection that belonged to *nothing* is again a repugnancy; no perfection.

P. Could there be knowledge in nature, without an *intelligent being?*

M. I have told you my thoughts with reſpect to every perfection. Knowledge muſt be the knowledge of ſome being. There can be no knowledge in *inert matter*, or *empty ſpace: an* intelligent being therefore muſt be different from theſe.

P. If you add all poſſible perfections together, could they exiſt without a being to whom they *belonged?*

M. If they could not when ſuppoſed ſeparate, they could not when taken all together. They muſt rather belong to a being as perfect as poſſible.

P. But how do you know that they are conſiſtent, ſo as to belong to the *ſame being?*

M. I have a notion that they cannot be inconſiſtent; and yet I cannot give a reaſon why.

P. Reflect a little, and conſider them as really inconſiſtent.——

M. You have ſet me right. If power were inconſiſtent with knowledge, it would be only *blind force*, *pure chance*, or *temerity*. If intelligence or knowledge were inconſiſtent with power, it would be as uſeleſs in the univerſe of things, as a *ſurdity of nature*; ſince however well it might contrive, it could perform nothing. *Power* without knowledge would be hurtful; and *knowledge* without power as unavailing to any thing elſe, as a *blind* and *unintelligent nature*; and to the being itſelf it would even be a miſery, as ſubjecting it to the cruel reflections of its own impotence to act what it ſaw was right.

P. Thus you ſee, if any perfection were inconſiſtent with another perfection, it would become an imperfection on account of that very inconſiſtency.

M. So I perceive: an inconſiſtency with a thing that is good, muſt be *bad*; and to be inconſiſtent with what is right, muſt be *wrong*.

P. What think you of *goodneſs*, or *juſtice* then?

M. Let me conſider; theſe things are new to me.——Goodneſs, I apprehend, ſuppoſes a *kind intention*, with power to make it effectual; that is, it includes the notion both of knowledge and power. Without power the intention would be

unprofitable; and without knowledge impoſſible. And if goodneſs were inconſiſtent with juſtice, it would only be an encouragement to diſorder and licentiouſneſs. As to juſtice——the very conception of it ſeems to include knowledge, power, and a right intention. And it is as much goodneſs or kindneſs, as the encouragement to virtue, and diſcouragement from vice can be.

P. You are of opinion then, that each of theſe perfections includes the reſt, or that any one of them conſiſts of all?

M. You have brought me, by this ſort of reaſoning, to ſee that it muſt be ſo; or that ſo far as it is otherwiſe, they are imperfect, or perfections in an inferior degree: for in a ſupreme degree *any one* naturally ſuppoſes *all the reſt* without limitation. Only I think goodneſs and juſtice reſpect intelligent beings; whereas power and knowledge may regard the material world.

P. Could power and wiſdom be manifeſted, think you, to the material frame of things, if there were no intelligent beings in it?

M. It muſt have been inconſiſtent to have deſigned to manifeſt theſe perfections to mere matter; ſince matter is not capable of perceiving the art and power manifeſted in itſelf.

P. If power and knowledge then were manifeſted in dead matter, for the ſake of intelligent beings, they come under the denomination of *goodneſs*.

M. This ſhews me indeed the nearer alliance of theſe perfections.——But theſe things, though I begin to find pleaſure in them, will carry us from our ſubject.

P. Let us diverſify the ſubject a little; there is pleaſure in variety; and we will return to the conſideration

ſideration of matter inſtantly.——Tell me therefore, ſince each of theſe perfections naturally include the reſt, can any thing in nature disjoin *ſuch perfections*, whoſe nature it is to be joined together?

M. I am really at a loſs what to anſwer here.

P. Conſider well what is in nature; and what is the nature of theſe perfections.

M. You have taught me now to conſider nature, as only conſiſting of *dead matter* on the one ſide, and *power* and *knowledge* on the other.—— Yes, this ſhews it me indeed. Since it is the nature of theſe perfections to be joined together, nothing in nature can disjoin them. For that thing, which could disjoin them, muſt be contrary to their nature. But the things of a contrary nature to *power* and *knowledge* are only *impotence* and *ignorance*, which are mere negations, or *nothing*, and can do nothing. Power and knowledge therefore are neceſſarily united in nature.

P. And the things contrary to *goodneſs* and *juſtice?*

M. Are *malice* and *tyranny*. But malice ſuppoſes *envy* for the want of power and knowledge to procure ſome advantage, which the malicious being is conſcious it has not. And tyranny ſuppoſes *fear*, for the ſame want of power and knowledge to ſecure advantages, which the being is, or ſuppoſes itſelf to be poſſeſſed of. And power and knowledge (the defect of which gives riſe to malice and tyranny) are neceſſarily united to goodneſs and juſtice.——

P. You ſeem to be thinking on ſomething farther.

M. By this I ſee, that it is the ſovereign degree of power *and* knowledge, that is neceſſarily and naturally

naturally united to goodneſs and juſtice. It is impoſſible that a being of infinite power and infinite knowledge, can ever be malicious or envious, or (therefore) tyrannical; ſince he can ſee nothing but what is below himſelf. But from the inſtances of malice and tyranny I perceive, that a finite degree of power and knowledge may be disjoined from goodneſs and juſtice; or it is their being limited, that can only disjoin them from the other two.

P. From what you have ſaid then, it follows, that malice and tyranny (or, in other words, *envy* and *fear)* have no foundation in nature, except a defect of power and knowledge; that is, except the two firſt negatives, *ignorance* and *impotence?*

M. So it ſeems to me.

P. And that the four perfections we firſt named, viz. *power*, *knowledge*, *juſtice*, and *goodneſs*, are united by their nature, provided they be in a ſovereign, or infinite degree?

M. It is ſo. And ſince nothing can oppoſe their nature, they are united by the ſtrongeſt neceſſity I can have any notion of.

P. But could theſe perfections have been produced, or have been the effect of any cauſe?

M. That ſeems to me wildly contradictory.

P. Why ſo?

M. The ſuppoſing them to have been produced, is the ſame thing as ſuppoſing them once not to have been; and then there could have been nothing to have produced them, except their *contraries*, which are mere negations. But it is the greateſt of contradictions to ſuppoſe, that *impotence* and *ignorance* ſhould produce infinite power and knowledge. So that they are abſolutely neceſſary in themſelves,——

P. So neceſſary are *power* and *knowledge* in nature, Matho, that if we deny their abſolute and inconditionate neceſſity, we affirm their abſolute impoſſibility; ſince there was nothing in nature to produce them. This again is another of thoſe inſtances, where it is impoſſible for the moſt diſingenuous *ſceptic* to doubt, with his utmoſt effort. They muſt likewiſe be *infinite*, or *unlimited*: for they could not have limited themſelves, or made themſelves leſs perfections than they *neceſſarily* were. That neceſſary power and knowledge ſhould leſſen, or limit themſelves, is both morally and phyſically impoſſible. And there was nothing elſe in nature to limit or leſſen them: nature conſiſted of nothing elſe. *Ignorance* and *impotence* are ſtill *nothing*. Add to this, that it is *ſomething poſitive* that muſt be infinite: and nothing is of ſuch a poſitive nature as ſuch perfections, and thoſe *neceſſary*. You ſaw before, that infinite joined to a negation (that is, *infinite nothing*) is abſurd. Infinite deadneſs, infinite weakneſs, infinite ignorance, makes the perfections, which are thus infinitely denied, again impoſſible.—— Laſtly, they muſt be undivided as well as unlimited, for the ſame reaſons, which it is almoſt needleſs to repeat. Diviſion is limitation. It is their nature to be united. They could not have divided themſelves. Infinite power, or infinite knowledge, could not have divided, and thereby leſſened itſelf: this is again both morally and phyſically impoſſible. And as there was nothing elſe in nature (for they make all nature, if I may ſo expreſs it) they could not have been divided: we muſt ſtill remember, that their contraries are nothing, and could not make a part of nature. —— Thus we have helped each other, Matho, to

ſuch a view of the *unity* and *abſolute perfections* of the SUPREME BEING, as your mentioning *living* and *immaterial power*, in oppoſition to the deadneſs of matter, laid in our way.

M. When one conſiders the neceſſary nature of theſe perfections, all things in nature elſe ſeem little and tranſitory, and almoſt to diſappear. It is really a noble ſpeculation! and no leſs comfortable than pleaſant, to find an *infinity* of power, and knowledge, and goodneſs, and juſtice, abſolutely neceſſary.

P. Virtue muſt triumph at laſt. The good man has ſo little reaſon to doubt, that he is not ſurer of what he is poſſeſſed of, than he is of immortal happineſs: but I mention theſe things a little prepoſterouſly to you now.

M. No; I underſtand them well, and ſhall often think on what you ſay.

P. Try the reaſons when you are merry or ſad, in health or ſickneſs, at death itſelf; you will ſtill find them hold.

M. Though this has been a ſevere bout to me, I am extremely glad we entered on the ſubject.

LIII. And here I obſerve, that this ſort of proof for the being of a Deity, though abſtracted, as indeed it ought to be, ſeems very natural. For as his exiſtence is abſolutely neceſſary, and independent of any thing elſe, ſo there muſt be a reaſon for it (or rather, the reaſon of it muſt be) independent from any conſideration of the material world.

P. The obſervation is juſt; and ſuch a proof muſt of conſequence be abſtracted, as having nothing to do with the material nature. It is ſuch a proof as would conclude, before matter exiſted, or

or after it ceaſed to be: and it would be hard to affirm, that the reaſon for the being of a God ſhould diſappear with the material univerſe. However, it is wiſely ordered (as we obſerved before) that the ſtrongeſt degree of certainty is brought down even to the methods of ſenſe: and it muſt be owned, though we may infer in an abſtracted manner, that the power and wiſdom of the Deity are neceſſary and infinite; yet without the wonders manifeſted in the creation, we could not have ſuch ſtrong and lively conceptions of theſe perfections: beſides, the pleaſing circumſtance of conſidering the Deity in the relation of our creator; and beholding conſtantly the operations of his power and goodneſs.——

M. To return then, ſince the exiſtence of a Deity is ſo many ways undeniable, and his power ſo viſible, what reaſons do the atheiſts give for ſaying, that matter and motion may do all that is done in nature?

P. I put the queſtion to you again, Matho: Do you think there could be any reaſons for ſuch an abſurd opinion?

M. I am ſatisfied there could be none ſolid.

P. Do you think they could even appear probable to an impartial enquirer?

M. That I cannot tell, unleſs I knew them. It is hard to conceive what men could mean, unleſs they had ſome ſhadow of reaſon, whereby they deceived themſelves at leaſt.

P. And notwithſtanding, you brought the point between you and them ſoon to a deciſion?

M. Yes, with reſpect to the motion of the heavenly bodies.

P. You have ſeen that matter reſiſts all change of ſtate, and therefore it reſiſts to be put in motion.

M. How then do they account for its being put in motion?

P. In truth, Matho, what they ſay is ſo ſilly, that, if I ſhould take their ſide of the queſtion, you would ſuſpect I wronged their arguments. They ſay, *Matter was eternally falling downward, through the infinite abyſs of ſpace; but that having ſome how or other a ſide-motion, its parts came to touch, and ſo formed a world.* How does this pleaſe you?

M. It is quite below contempt. I am a thouſand times more ſurpriſed than I was, that ever there ſhould be an atheiſt in the world.

P. Let them ſay then what they will, as long as they deny an intelligent and powerful government in nature; I ſhould expect now that you could ſhew the abſurdity of what they advance. And pray, though we ſhould allow that motion were thus natural to matter, would it not be as much a dead ſubſtance, as if it had been without motion from eternity?

M. It certainly would; for matter at preſent is as much a dead unactive ſubſtance, in all the changes it undergoes, as if it remained ſtill in the ſame ſtate: and this proves to me, that though ſuch motion were natural to it, nothing could be effected, unleſs this motion were over-ruled by *intelligence* and a *governing mind.*

P. Your reaſons for ſaying ſo.

M. It is almoſt a ſhame to argue againſt the atheiſt's ſuppoſition. If matter had naturally ſuch a tendency, it muſt ſtill fall down through the immenſity of ſpace, as well when in contact, as in ſeparate particles, without ever producing any thing. And this ſhews us again, in a very particular manner, the abſurdity of an *univerſal downward,*

ward, or that gravity was a connate and inherent property of matter. But let us even ſuppoſe that a mutual attraction between all its parts, ſuch as we took notice of before, were eſſential to matter; or that its particles could act where they are not, and that to all diſtances: this could only bring the whole ſubſtance into one prodigious heap, which muſt afterwards remain without change or motion of its parts. And we ſee before too, that to prevent the great bodies of nature from coming thus together, they are made to move in circular orbits, whereby a centrifugal force is excited in them.

P. Suppoſe once for all, that every ſort of motion, backward and forward, circular and rectilinear, were natural to the particles of matter; and then conſider whether they could produce a world.

M. Are you able to make ſuch a ſuppoſition as this, Philon? I thought I had gone lengths enough. It is abſurd to ſuppoſe ſo many contradictions, in order to try the truth of any thing, ſince one contradiction muſt ſhew it falſe. It is to bid me conſider whether the atheiſt's ſcheme would be poſſible, if it were three or four times impoſſible. It was probably by conſidering things in this confuſed way, that the atheiſt at firſt bewildered himſelf; and that other men's eyes have been dazzled. Matter reſiſts to be put in motion, and when put in motion, it reſiſts a change of direction. Thus if the particles moved all one way in this ſtraight-lined motion, we have ſeen that nothing could be effected. If they all moved contrary ways when they encountered, the ſtronger muſt carry the weaker along with them; or if the contrary forces were equal, both muſt reſt.

And what agrees to two particles, agrees to the whole maſs. Some parts of matter might ſtill move farther aſunder through the infinite ſpace; and the motion in others being deſtroyed, they muſt remain eternally at reſt.

P. You reaſon perfectly well, Matho; the quantity of motion once loſt, could never after be recovered on this hypotheſis; nor indeed on any hypotheſis, except by *immaterial power*. It is thus the quantity of it, which is ſtill decreaſing by the action of matter upon matter, is conſtantly renewed by the firſt cauſe. Let the motions of the particles therefore be ever ſo various and irregular, when contrary they muſt deſtroy one another, and the particles after that reſt; otherwiſe the atheiſt might ſuppoſe his matter in a ſtate of reſt at firſt, and then to impreſs motion on itſelf. And after all, nothing could be produced on theſe ſuppoſitions, but motion by ſtraight lines or endleſs reſt. Much more might be added if it were neceſſary. Though he ſhould imagine the particles to ramble backward and forward, like *gnats* flying in the air in a ſummer-evening, this could never produce *coheſion of parts, order or arrangement*. Matter agitated by ſo many wild and tumultuous motions, would only ſo much the more ſtand in need of *a powerful* and *intelligent cauſe*, to reſtrain *theſe*, and impreſs other motions conſiſtent with ſome regular deſign.

M. I underſtand the caſe as you expreſſed it in all its perplexity. The more they multiply theſe blind and unguided motions, the more they make an *intelligent principle* neceſſary, to overrule and direct them: ſince matter toſſed in ſuch a wild manner, muſt be more unmanageable, than when at perfect reſt.——But as there

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is no pleaſure in purſuing theſe abſurdities any farther, and as we have not yet ſpoke of the *coheſion of parts* in matter, otherwiſe than as it came in our way accidentally; pray reſume that ſubject a little.

LIV. *P.* Tell me then; muſt not any particle of matter, the leſs it is, yield to the leſs force impelling it?

M. Without all doubt; and the greater it is, it muſt require the more force to be moved with the ſame celerity.

P. Could a particle reſiſt a hundred or a thouſand times a greater force than that is to which it yields?

M. That is plainly repugnant; or it is ſaying, *the particle can do more than it can do.*

P. And is not the ſame thing true of any other equal particle?

M. It is as true of the ſecond as of the firſt, and of the third as of the ſecond, and ſo on, for any number of equal particles.

P. Let us ſuppoſe then that a bit of iron conſiſted of three or four ſuch particles; and do you think that theſe particles could be ſeparated from each other, by the ſame force by which they could be moved if they were ſeparated?

M. No; not by a thouſand times a greater.

P. Is this thouſand-fold reſiſtance made by the particle itſelf?

M. Certainly it is not; for that would be to affirm that it made a thouſand times a greater reſiſtance than it can make; a ridiculous contradiction.

P. Whence does this exceſs of nine hundred and ninety-nine times a greater reſiſtance

than the particles can make, proceed then?

M. This diſtinct manner of arguing, Philon, ſhews me undeniably, that ſuch a prodigious exceſs of reſiſtance is the immediate effect of immaterial power. But is any thing offered here with a view to account for this wonderful effect otherwiſe? I ſhould think that men muſt have inſtantly owned the hand of the Deity in ſuch a plain caſe.

P. It hath been ſuppoſed that ſuch little particles are joined together by certain other leſs particles, in the form of *hooks* or *claſps*, which keep them fixt together.

M. They ſhould have ſuppoſed then, that the whole ſubſtance of iron, or other ſuch hard bodies, conſiſted only of theſe *claſps* or *hooks*: for ſuch bodies make equal reſiſtance every way, to be divided, or have their parts ſeparated. Beſides, muſt not ſuch *claſps* be leſs than the parts they claſped together?

P. We can hardly conceive it otherwiſe.

M. And muſt not the *parts* of theſe claſps be leſs than the claſps themſelves?

P. Without doubt.

M. What then claſps together the parts of theſe little machines?

P. That I cannot tell.

M. This leaves the point unſolved, or rather makes the difficulty greater: ſince (as we obſerved juſt now) any particle, the leſs it is, muſt yield to the leſs force impelling it. And here the direct contrary is ſuppoſed.

P. Such ſuppoſitions, Matho (that I may acquaint you with this by the way) are frequent in the mechanical explications of the appearances in nature.

M. What do you call *mechanical explications*?

P. That

P. That is called a mechanical explication, when the effects, which appear in matter, are ſaid to be produced by other matter, of which the preſent caſe is an inſtance.

M. I underſtand; when the matter of the body is allowed unable to produce the effect, other matter is ſuppoſed ſufficient.

P. That is it.

M. I ſhould make no ſcruple to reject ſuch explications, eſpecially where the greateſt efficacy is aſcribed to the leaſt particles, which certainly have the leaſt *reſiſtance*, by which only they can effect any thing. And the preſent explication of the ſtrong coheſion between the parts of bodies, only ſuppoſes that it is the effect of the ſtronger coheſion or leſſer parts.

P. Some have endeavoured to explain the coheſion of the parts of bodies, by the preſſure of ſuperincumbent ſubtle matter; for which ſome experiments are alledged.

M. Does not this matter preſs upon all bodies equally?

P. Without doubt.

M. Then the parts of all bodies ſhould adhere to each other with equal force; and it would be as difficult to break a piece of glaſs, as a plate of iron. Beſides, how could this matter get in, to cauſe coheſion between every part of the hardeſt bodies? By pervading them all poſſible ways, it ſhould rather looſe the coheſion, and diſſolve the body.

P. A great philoſopher was of opinion, that *reſt* only cauſed coheſion between the parts of bodies.

M. How many degrees of reſt are there? The degrees of coheſion ſeem innumerable. Reſt be-

tween the parts ſeems rather the conſequence than the cauſe of coheſion. And if I can overcome the reſiſtance of the whole body, by putting it in motion; why ſhould I not be able to overcome the reſiſtance of a part of it ſeparately?

P. There are other explications of this appearance, but not worth mentioning.

M. And from thoſe you have mentioned, I am ſtill more ſatisfied, that the ſtrong impreſſion conſtantly made on the parts of firm bodies, which you ſhewed me from the inſtance of the wire ſuſpending a weight, cannot be the effect of a material cauſe. A ſmall bit of iron could bear an inconceivable preſſure, before it could be flatted, or the parts of it ſeparated from that contact they are in with others; and yet the natural reſiſtance of the whole piece, proceeding from its inertia or deadneſs, might be overcome by the ſtrength of an hair.

P. You are likewiſe ſatisfied that this impreſſion muſt be conſtant.

M. As much as I am, that the ſtrength and firmneſs of theſe bodies, which ſupport the largeſt edifices, and bear the greateſt weights, muſt be conſtant. *The weight does not increaſe, but try the ſtrength of ſuch bodies.* If it were otherwiſe, the ſtatelieſt piles of building muſt inſtantly tumble; and the bodies of animals be looſened into atoms. Nothing in nature could remain the ſame; nothing could bear to *touch* or to be *touched.* I need not mention what occurs to me every time I think on this ſubject; that if this impreſſion were not *various* to conſtitute the different ſpecies of bodies, if all were as hard as iron, or as ſoft as wax; if all were equally brittle, or equally tough and ſupple; the fitneſs of one thing to another,

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and the use of all, would be lost in nature. These things fill the mind with amazement, which is ever new.

P. You said, without this constant impression, the bodies of animals must instantly be loosened into atoms.

M. Certainly. Every bone in our body bears a constant impression of force, equal to the greatest resistance it could make, before it were broken. And this, indeed, is astonishing (for you make me attend to it) that our bodies constantly bear an impression, which, one way applied, would crush and dissolve them; and another way applied, is not only not felt, but preserves us! Besides, there is almost all the difference of impressions in the animal body alone: the bones are hard, the flesh soft, the sinews tough, the blood loose and fluid.

P. The more we think on these things, Matho, the more various we must see our immediate dependence on the power of the Deity to be.

LV. *M.* There is still another particular in the cohesion of the parts of bodies, which seems to me exceeding wonderful.

P. What is it?

M. Though the variety of this action, and the different force of the impression in different sorts of bodies, is beyond our conception; yet if we might compare things which we do not comprehend, one with another, the subtlety of the action appears still more astonishing.

P. I should be glad to hear your thoughts on this head.

M. We observed from the beginning, that cohesion is only between the contiguous parts; the

whole force of the action, therefore, is only between theſe: but they are the leaſt parts of matter which can be contiguous to each other, ſince matter can only come to contact by its ſurface, and not by its depth or ſolidity. So that, I think, they are only the ſurfaces of the leaſt parts, that make all the reſiſtance, even in the very hardeſt bodies, as *ſteel* or *adamant*. So far I ſhould have a clear conception: but if I conſider theſe ſurfaces, as not the ſolidity of the parts, but that theſe parts muſt have other parts; the ſubtlety of this ſtrong action, which affects coheſion among the parts, exceeds my imagination. For I can conceive no part of matter ſo little, but what might afford room for a ſeparation, or for two new ſurfaces to be made out of it. This multiplies the action to a minuteneſs that ſurpaſſes my faculties (as I ſaid) and yet without diminiſhing the ſtrength of it.

P. Here, I believe, every body's faculties muſt fail them, Matho, as well as yours. What you have ſaid, ſeems very juſt; and, beſides what you intended, it ſhews us a new reaſon, why this ſtrong and ſubtle action could neither be the effect of other matter, nor of theſe little particles themſelves.

M. That I had in view, when you told me of the *preſſure of a ſuperincumbent ſubtle matter*. It is ſtrangely contrary to reaſon, to ſuppoſe, that ſuch minute particles ſhould be ſo impelled by other matter, as to exert ſuch an effort. Thoſe ſmall atoms could not afford *room*, *ſcope*, or *ſurface* enough, for other particles to act upon them: and then the impulſe of other matter could never explain, but muſt perplex this affair beyond conception. If other matter impelled a particle on

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all sides equally, the contrary actions suspending each other, that would dissolve its cohesion with any other particle. If the particle were impelled more strongly on one side, that must loose it on the other. Lastly, there should be more of this *other matter*, I think, in the very hardest bodies, than of their own proper matter; since every atom of them would want to be impelled on all sides. This would be a strange round-about supposition, made to shew the cohesion of the parts in bodies impossible: and the cohesion of these other particles is still left unaccounted for; as also how they come to have this motion and direction, so as to impel constantly all the parts of all bodies.

P. Besides, Matho, since the force wherewith every little particle attracts the contiguous particles, acts on all sides, and every where round; and since no particle can have opposite tendencies, or a tendency, to all contrary sides at once; it is plain that cohesion can neither be the effect of any other matter from without, nor of these particles themselves from within; but *the constant impression of a superior and divine power*, exerted in a manner by us altogether inconceivable.

M. I understand what you say: a particle could no more have a tendency to all sides at once, than it could move to all sides at once: and a tendency to one side could never cause cohesion, even on that side. It is delightful to see a point, which carries such important consequences along with it, admit of so clear a decision.

P. Finally, Matho, if we consider what you expressed so well in the beginning, when you said, that the minuteness of the action surpassed your faculties: if we consider, I say, that there is no particle of matter so little, since it is a thing so-

lidly extended into length, breadth, and thickneſs, which doth not conſiſt of other leſs parts, and theſe of others, till we are quite loſt in the conception; we muſt own that this ſubtle action of coheſion deſcends ſtill with undiminiſhed force: ſo that the very ſolid extenſion of matter, that is, the very exiſtence of it, is the indefinent effect of *divine power.*

M. O Philon! the wonderful action! I ſee almoſt with my eyes, that the conſtant exertion of the power of the Deity is the very *baſis* (if I might ſo ſpeak) of the exiſtence of matter. I now ſee, what great reaſon you had for ſaying, at the beginning of our ſecond conference, that no man ever had, nor ever will have, a notion of the ſubſtance of matter, otherwiſe than as the power of the Deity is conſtantly exerted upon it; or rather, *exerted in it.*

LVI. *P.* If you reflect a little, you will perceive the other ſort of attraction no leſs wonderful in ſeveral reſpects.

M. I find it difficult to recall my thoughts ſo ſoon, to the conſideration of another ſubject.

P. As the attraction of coheſion ſhews the various and inconceivable power of the Deity, wherever matter is; ſo the attraction of gravitation ſhews the ſame power no leſs various and inconceivable, even where it is not.

M. Make this a little plainer.

P. You inferred rightly before, that the attraction of gravitation muſt prevail through the whole planetary ſyſtem, becauſe if our earth (or any of the planets) came to a place where there was attraction to no center, its courſe would be diſturbed, or it would ſeem to be deſerted. You obſerved,

ſerved, that ſuch a world as this required tranſparency and clearneſs, that the light might not be intercepted, nor the cœleſtial bodies darkened, by matter lying ſcattered at random, or uſeleſs and unemployed in the ſyſtem. Hence you concluded that this attraction of gravitation was not only the cement of particular bodies, but of the whole univerſe.

M. I ſee it muſt be ſo indeed; the action muſt be propagated through the whole intermediate ſpace. This is aſtoniſhing; and I ought to have ſeen it before.

P. There is a particuliar here which makes it ſtill more aſtoniſhing, though you cannot yet underſtand it: for the intenſity of the action is different at every different diſtance, through the whole ſpace lying between the attracting bodies.

M. I remember you ſaid, the attraction of the ſun on each of the planets was different, which required a different degree of projectile force to be impreſſed on every one of them.

P. Conſider then any *one particle* of dead matter in the planetary world, as attracting *every other particle*; and endeavour to conceive in your mind how various and wonderful the action of *this one particle*, or the power exerted with reſpect to it, muſt be.

M. Alas, Philon! this confounds the force of imagination a thouſand times. A ſmall part of ſuch diverſity would be more admired, becauſe better underſtood. I now ſee that the multiplicity of the action as much overpowers our faculties in this caſe, as the ſubtlety of it did in the former. But indeed one's amazement is divided; and which ever of the two any one conſiders at the time, he muſt think that moſt wonderful. The mind

mind of man is too narrow for theſe things.

P. After this think a little whether the infinitely various action of *this ſingle particle* could be the action of other matter upon it.

M. One who has the view, Philon, which I have at preſent, can hardly think on that ſuppoſition with patience. If we conſider that this is the condition not of one ſingle particle of matter, but of *every particle*; to ſuppoſe that all this is the effect of other matter acting upon them; is to imagine that there is infinitely more of *this other inſtrumental matter* in the univerſe, than of the matter which it is ſuppoſed to move and actuate. This is a ſtill more inartificial and round-about way, than the *ſubtle incumbent matter* in the former caſe. If nothing but the action of matter upon matter will ſerve, what is it that moves this *other inſtrumental matter?* Or where will the inſtrumentality and ſubordination of matter to matter end? This is to put the Deity quite out of ſight.

P. Leaving therefore theſe infinitely various, interfering, oppoſite actions, propagated without confuſion or diſorder, through the immenſity of ſpace, from every particle to every particle, as the proper work of *divine power*; conſider, in the laſt place, that the action of matter upon matter can only be according to the external ſurface, and in proportion to the extent of that ſurface: but attraction operates in proportion to the ſolidity of matter; that is, it operates *from*, and *through* the whole internal ſubſtance of matter.

M. I ſee plainly that if matter acted thus on matter, neither the matter acted upon, nor the matter that impelled, could be ſolid or impervious to other matter. This is the work of the ſame

Being,

Being, and of the ſame wonderful kind, as coheſion was diſcovered to be juſt before.——

P. Theſe, Matho, are ſome conſiderations concerning the nature of matter in general, which ſhew us the mighty power of the Creator conſtantly exerted in all objects above, below, and round us: nor do they require any deep learning to be underſtood, nor other preparation than common ſenſe, and an unprejudiced mind. As for particulars, you muſt have recourſe to thoſe who have applied to the ſeveral branches of natural knowledge, and obliged the world with their diſcoveries.

M. I am now indeed ſatisfied that we can neither turn our eyes nor our thoughts to any one object in all nature, where the power of the Deity is not the firſt, or to ſpeak more truly, the only thing that occurs to us. The thought is awful and raviſhing!——You concluded lately that *the particles of light* were matter or body, becauſe they excited heat and motion in other bodies: pray acquaint me with ſomething of their nature.

P. I can give you but ſmall aſſiſtance here, nevertheleſs it would not be well on my part not to tell you all I know, which may be done in few words.——They are the ſubtleſt matter we know, and have the ſwifteſt motion: but ſtill they are matter, attracted and repelled by other matter, and have their motion bent and reflected, as much as a tennis-ball.

M. It is but reaſonable that the matter, by which *viſion* is performed, ſhould be extremely ſubtle: viſion, I think, is the moſt ſubtle of our ſenſes; and groſs or palpable matter muſt both hurt the ſenſe and darken the object; or the light itſelf would be ſeen, and not the object it fell upon.

But

But what may the velocity of the motion of light be?

P. From the eclipſes of the ſatellites of Jupiter, it is computed that light comes from the ſun to the earth in about eight or ten minutes.

M. I believe I need not ſtudy to conceive this velocity from any compariſon.

P. You need not: the ſwiftneſs of the earth's annual motion, which you admired ſo much, does not at all come near it.

M. How is the motion of light bent or changed?

P. If light were not reflected from bodies, you could ſee nothing.

M. I ought to have remembered that the ſunbeams are eaſily turned to all the corners of the room by a mirror. And now that I think on it, if the paſſage of light were not bent, I could not ſee objects monſtrouſly diſtorted through uneven glaſs.

P. In that caſe, when the ray is refracted or bent, you think the object is in the direction of that part of the ray which enters your eye; though the part of the ray which falls on the glaſs is in another direction. This makes the object ſeem to change its place, or disjoins the parts of it.

M. This ſolves many doubts to me, which I ſhall not trouble you with obſerving.

P. The rays of light, in paſſing by the edges of bodies, are likewiſe bent or attracted towards them, though this can only be obſerved in certain delicate circumſtances.

M. This ſeems to explain to me a thing which I have often admired. In going by *paling* or *rails*, all of parallel ſticks, you will perceive both the paling and the objects at a diſtance behind it to tremble

tremble or dance as it were. I have walked backward and forward for half an hour together to conſider this. Now I ſuppoſe this is, becauſe the eye paſſing through theſe bent rays near the ſides of the ſticks, and coming immediately to other rays not bent, ſees the object ſuddenly change place, and the whole by this means to have a tremulous or dancing-like motion.

P. You explain the appearance very ingeniouſly, and truly too, in my opinion.

M. If light requires time to move from place to place, if the body it comes from be far diſtant, and alſo move ſwiftly, we cannot ſee it in the real place: for while the light is a coming to us, the object may have moved a great way.

P. You are in the right: and there is an argument brought from this to ſhew the abſurdity of the Ptolemaic hypotheſis, where the whole heavens are ſuppoſed to turn round in four and twenty hours. For if we ſuppoſe the diſtance of a fixt ſtar only ſeventy or eighty times greater than the ſun's, ſo that the light ſhould take twelve hours in coming from the ſtar to us; it ſhould be ſeen ſetting in the weſt, while in reality it were riſing in the eaſt, and contrarily.

M. That would be a monſtrous inconvenience: the motion of no body therefore can bear any proportion to the velocity of light, leſt we ſhould be conſtantly deceived in the place of moving bodies.

P. It is reaſonable to think ſo.

M. What is the reaſon why bodies are of different colours, when light is all of one colour?

P. You preſs me too hard: light is not all of one colour, when the rays are ſeparated, which may be eaſily done according to their different de-

gree of refrangibility (as it is called) they are found to be of different colours, as *red*, *orange*, *yellow*, *green*, *blue*, &c. and a ſcarlet ribbon, for inſtance, reflects the red rays moſt ſtrongly; but what the reaſon of this may be I cannot tell.

M. I believe indeed the rays muſt be of thoſe colours from what I ſee in the rainbow.——But not to trouble you more on this head, anſwer me only one other queſtion. Pray what ſort of men were thoſe *ſceptics*, whom you mentioned once or twice in our diſcourſe?

P. They were a ſort of philoſophers, whoſe principle it was to doubt of every thing.

M. Did they make a principle of it?

P. They did; for any one undeniable truth, muſt have confuted their whole ſcheme.

M. Then I preſume they muſt have been much put to it in ſome caſes: you ſhewed me an inſtance or two above, where doubting ſeemed to me impoſſible. What reaſon could they give for doubting that *the part was leſs than the whole?*

P. They avoided coming to ſuch particulars.

M. Had they no pretence for this affected ſingularity?

P. They pretended there were contrary and equal reaſons *for* and *againſt* every thing that could be affirmed.

M. Were they certain of this?

P. That had been to affirm ſomething contrary to their principle.

M. They could not be certain then whether they had reaſon to doubt, or not?

P. They were not agreed on what principle to found their univerſal doubting, and therefore were divided into three or four denominations.

M. Were doubters ſo ſtiff in opinion?

P. The

P. The honour of their *sect* obliged them to it.

M. I have enough of them *. And now, Philon, with your permission, I would go and consider by myself what we have been discoursing of, that I may not give you the trouble to tell me the same things over again, when I come next to you.

P. That is not your way, you rather improve upon what is told you. But perhaps we should speake more to the purpose if we spoke less at a time.

* We may see the genius of scepticism humorously represented in a few sentences of a letter of Henry Stephens, before the Leipsick edition of *Sext. Empiricus*, 1718.—*An ex animo, et ut sentis, ita loqueris? Ingenuitas vestra fateri? The answer is, ὁ μᾶλλον τοῦτο ἢ ἐκεῖνο. Hic libellus seriòne tractat, an nugas? ἐπέχω. Ad hæc saltem respondes: esne philosophicum ejus argumentum? ὁ καλλαμβάνω. Age, quid dissimilium constituúmque tibi de illo libello est? οὐδὲν ὁρίζω. At mihi tuum de illo sententiam, quæcunque sit, aperi? Imo nulla mihi sententia est, utpote nihil opinanti. Quid facis igitur? συναίρομαι διαλογῷ, &c.*

THE

THE

Fifth CONFERENCE.

The conſequences of the inactivity of matter conſidered with reſpect to the productions in, and about our earth.——Matter owes its origin to an immaterial being. The ſimple exiſtence of material ſubſtance ſhews the infinite power, *and the various ſpecies of things formed out of it, the* wiſdom *and* goodneſs *of this being. That any ſort of matter we know hath paſſed through divers operations, and various art, before it falls within our knowledge. The imperceptible tranſlations from dead matter to vegetating bodies. From the moſt imperfect* plant *to* man, *vegetables and animals riſe in a continual* ſcale *of perfection. Propagation of plants and animals by ſeeds, not mechanical; or the ſeed not the cauſe of the future plant, nor the former plant of the ſeed. The one appointed to follow the other, in order to conſtitute a ſettled courſe of nature. Hence an* eternal ſucceſſion of cauſes and effects, *a groundleſs and unphiloſophical ſuppoſition. The mutual aptitudes, relations, and connexions between the parts of the* ſcale, *ſhew the unity of deſign. This ſhewn in the article of* food. *Of the ſucceſſive* evolutions *of bodies, in the formation of many ſpecies of winged inſects. That all theſe inferior creatures operate blindly, and yet regularly; or are directed by a principle, more perfect than the reaſon of mankind. Monſtrous productions occaſioned by acci-*

dents,

dents, diſturbing the regular proceſs in the formation of animal bodies, according to the ſettled courſe of nature.

LVII. *P.* WHAT is the meaning of this viſit, Matho, ſooner than ordinary? For though I am always glad of your company, I did not expect to ſee you for ſome days.

M. I underſtand, from what you ſaid before we parted laſt, that the inactivity of matter muſt have other conſequences, beſides thoſe we then conſidered; and I was impatient to be informed of them more particularly.

P. What other conſequences do you mean?

M. There is a great variety of particular bodies, in and about our earth, which are formed out of this *dead ſubſtance*; now the conſideration of theſe can be no leſs delightful and entertaining, than that of the great bodies of the univerſe. And it ſeems to me abſurd, to neglect the inſtances of power and wiſdom that are near and round us; and only to take notice of thoſe that are ſo far diſtant as the heavens.

P. Well, what are your thoughts of matter, after you have conſidered it ſtill more narrowly?

M. You know I began to ſuſpect matter after our firſt conference: but before you ſhewed me ſo fully, at our laſt meeting, the nature of *coheſion*, I ſtill thought matter ſtood in need of no ſupport from any thing elſe, to be what it is; that it owed its origin to no cauſe, was neceſſary in itſelf, and above the reach of any power, to be by that deprived of exiſtence. Now, I find, I was under a grievous miſtake in this whole affair; and believe all young people fall naturally into the

ſame

ſame prejudice; though nothing, in my judgment, concerns us more nearly, than to be early convinced, that the courſe of nature, and ſtability of things, muſt reſt upon another foundation.

P. On what other foundation?

M. On the *power* and *government* of an *almighty being*, which affords a better proſpect, and more ſecurity to mortals, than ſuch a dead ſubſtance.

P. Might not this viſible frame of things have exiſted always, and without any cauſe either to govern, or give it origin?

M. After what has been ſaid, it is perfectly ſuperfluous to aſk that queſtion. The rude ſubſtance itſelf, not wrought up into any form, nor diverſified by any art, ſtands in need of a conſtant ſupport, that it may exiſt in *any manner*; and farther requires an almighty artiſt, not leſs ſkillful, than powerful, to make out of it ſuch a beautiful fabrick as we behold. I ſhould ſooner believe a man who was to tell me, that *iron* firſt made itſelf, and after that, faſhioned all thoſe curious pieces of art, which are wrought from that metal; than one who told me, that this viſible frame of the univerſe is not the work of a powerful and wiſe cauſe. *What ſtands in need of a conſtant ſupport from another cauſe, that it may exiſt any way, ſtood in need of the power of that cauſe, to give it exiſtence at firſt.*

P. Your argument is of the right ſort, Matho, and carries along with it all the evidence of an axiom. That only can be without a beginning, which cannot poſſibly have a cauſe; a being, to wit, of infinite power and knowledge: contrarily, therefore, a thing which cannot be without a cauſe, and is void of all perfection, muſt have had a beginning. And ſuch a ſubſtance is dead

dead matter. Theſe are the two moſt oppoſite things to each other, we can imagine. Hence, if this rude and unwrought ſubſtance ſhews us, by its bare exiſtence, the wondrous, extenſive power of the Creator, the variety of things that are faſhioned out of it, their uſe, and application to ſomething always higher, muſt equally convince us of his knowledge and wiſdom. Nothing is wanting to complete the *mighty deſign*; and thoſe things, which we might think ſuperfluous, are ſtill neceſſary to the intended variety, and to carry up the *ſcale* of created beings. For this variety is not propoſed for oſtentation of power; that would be a falſe thought; but to finiſh conſiſtently a great and harmonious ſcheme.

M. To whom ſhould the Deity make oſtentation of his power? That would be to ſuppoſe beings capable to underſtand and fathom the greateſt things he could perform. This variety muſt have a higher end. Every thing rather ſhews infinity of power, conducted by infinite wiſdom.

P. And thoſe ſet on work, likewiſe, by the moſt diſintereſted goodneſs. Theſe perfections are not only neceſſarily united in their nature, but united alſo in the effects they produce.

M. It muſt be ſo: if they were ſeparated in the effects they produce, it would come to the ſame thing, as if they belonged to ſeparate beings, if that were poſſible; and the effects of power might be hurtful. I ſaw before that a ſovereign decree of power and knowledge muſt naturally raiſe a being above *fear* or *malice*: ſo that *goodneſs* muſt be the motive, when infinite power and knowledge work; or, without this motive, the univerſe could never have exiſted.

P. Let us remember then, what was concluded

before; namely, *That the very reſiſtance of matter to perform any effect, is made the means of its doing all it performs*; and we muſt be ſatisfied that the wiſdom and power, and therefore the kindneſs of the Deity, could not have been more conſpicuous any other way, than by employing to ſuch a variety of purpoſes a thing, which, in itſelf, or to a being of leſs power, is unfit for any purpoſe.

M. This variety, even an unſkilful ſpectator muſt admire, by beholding the outſides only of the works of nature: he can direct his view no where, but he muſt behold things great, curious, and beautiful, made out of this unpromiſing ſubſtance. It ſhines and warms, it cools and refreſhes; it is made light to the eye, ſound to the ear, and by a wonderful contrivance, nouriſhes and maintains our bodies.

P. The uſefulneſs of it, therefore, is equal to the variety: and this is that, Matho, which hath brought it into ſuch admiration, and really made it the deity of mankind. For while it is made to recruit the decays of our bodies, and gratify every ſenſe, by the noble appearance, the beautiful colour, the fragrant ſmell, or delicious taſte; we do not conſider the power and contrivance by which all this is effected. We forget to carry our views to the juſt extent; for certainly nothing could have been better fitted, to give us the firſt leſſons concerning the power and wiſdom of the Creator, than to conſider the poorneſs of the ſtuff every where heightened by art, and made uſeful in the application. The very deadneſs and inactivity of matter is diſguiſed by the power that actuates it, and lies concealed under a thouſand beauties of life and vegetation. Nor can we poſſibly be miſtaken about it, ſince we ſee it again

in

in its fading and corrupted ſtate. What does the fineſt complexion, or the moſt beautiful flower, ſoon end in?

LVIII. *M.* It is the uſefulneſs, the variety, and the contrivance of thoſe things round us, which we daily behold with ſo much inattention, which I would have you explain to me at preſent; that for the future I may behold them with ſome ſort of intelligence and rational pleaſure. It is either ſtupid, or ſhameful, for a rational being to walk conſtantly amidſt ſuch inſtances of contrivance and power, with the indifference or inſenſibility of an unreflecting animal. This, as I ſaid, was what haſtened my return, ſooner than you expected.

P. Willingly, Matho, would I aſſiſt you in ſuch a reaſonable deſign, if I knew where to begin, or were not afraid of obſcuring theſe matters, by the confuſed hints only which I am able to give you. Therefore, as I told you, when we laſt parted, you muſt have recourſe to the works of thoſe great men, who have ſucceſsfully enquired into nature. The ſubject here is not one, but as many as there are different ſpecies of natural bodies: each of which require a ſeparate ſtudy, to underſtand but a part of the art and contrivance employed in it; nor have theſe things been treated with that connexion and dependance one on another, ſo as to bring them under one general view.

M. We need not be ſolicitous about a method, ſince none can be obſerved in ſuch a converſation as this: I only want to be directed to the moſt general conſiderations, that I may have ſomething to exerciſe my thoughts upon, when, perhaps,

I ſhould otherwiſe be idle.——Pray what did you mean, juſt now, when you ſaid that this great variety is neceſſary to carry up the *ſcale* of created beings?

P. Every thing, Matho, above rude and unwrought matter, riſes in art and contrivance, the farther we advance, or the higher we can go. Many are the productions, before we come to the ſeveral ſpecies of *plants* and *animals*; of which there is an amazing variety: and yet there is a gradation of perfection from *kind* to *kind*, through the whole, where every ſpecies is raiſed above the former, by gentle and eaſy tranſitions. Thus a *continued relation* runs through the entire ſyſtem of material beings (or rather through the whole creation) which joins the *leaſt* with the *greateſt*, and ſhews the whole work to be *one*, and the effect of the ſame power and knowledge.

M. I ſuppoſe you mean, that in ſome ſpecies of plants and animals the art is more acceſſible and ſimple; but in the next ſuperior kind the ſame art is continued, and farther heightened with ſome additions or variations, as it were to lead us from the more ſimple to the more complex works of power and knowledge.

P. You expreſs my meaning exactly.

M. This is both pleaſant and intelligible, and juſtifies, I think, the inference you make, *That the whole work is one, and the deſign of the ſame power and wiſdom.* For I eaſily conceive that an *earth-worm* is more ſimple in its parts and compoſition, than a *ſnail*, which carries its covering or houſe on its back, and hath eyes in the points of its horns, as I have heard; and that this creature is not ſo complex as a *ſpider* or *ant*, who move by the help of feet, and have a variety of limbs;

and

and that theſe inſects again are more ſimple in contrivance than a *fly* or *knat*, who, beſides their motion by feet, have alſo wings to ſoar aloft.

P. You have named ſome of the wonders of the inferior creation, Matho, and ſpeak ſo diſtinctly of thoſe things, that one would think you had been making your obſervations before-hand. If it be doubtful whether the ſnail hath eyes in the points of its horns, it is certain the *ſpider* hath ſeveral pair of them: and the different ſorts of motion in theſe creatures, with the different artifice by which they are effected, will always excite our admiration.

M. Theſe objects fall generally under our obſervation, and they require but little reflection. But pray what productions are there before we come to the ſpecies of plants; or which lie betwixt theſe and unwrought matter?

P. The firſt thing we perceive in this ſubſtance is *workmanſhip*; therefore we cannot in propriety ſay that a ſtone of any ſort is unwrought matter. No body could imagine that a ruby, an emerald, a diamond, or any of thoſe ſtones that are called *gems*; or that a magnet, marble, flint, or ſo much as a common pebble, is rude and unwrought matter. If we conſider cryſtal, amber, all ſorts of minerals and metals; ſalts of all kinds; none of theſe certainly is matter in its primogenial form and texture.

M. They are not indeed; but muſt have undergone farther art and workmanſhip, before they could appear in any of thoſe forms.

P. Though we know not exactly how theſe are produced, yet productions they are; and (as you ſay) various art and power is exerciſed on every different ſpecies of theſe, as much as on

the ſtone of a cherry, the tooth of an elephant, or the horn of an animal, concerning the formal production of which we are very little wiſer. Water itſelf, dropping from the roof of ſome caves, is ſoon after congealed into ſtone. Marble was once not hard, otherwiſe parts of different bodies could not have been found in it. You obſerved before a variety of ſubſtances formed in the animal body; bones, ſinews, fleſh, blood, and not rarely one ſort of ſtone; all which are yet made out of the ſame common aliment.

M. I am entirely ſatisfied in this particular. Matter, that had undergone no workmanſhip, muſt be conceived to be uniform and all alike, without variety of impreſſion, or different degrees of firmneſs, coheſion, or conſiſtency, ſuch as we ſaw it to be when the *great bodies* of the univerſe were formed. All farther difference muſt be the effect of farther power and art.

P. It muſt be ſo; for all growth and vegetation, even of the hardeſt ſubſtances, is performed by the new accretion of imperceptibly ſmall particles: and theſe ſubſtances are again diſſolved into particles as minute and imperceptible.

M. You ſhewed me before, that we could form no conception of matter, but as the power of the Creator is exerciſed in it, to effect coheſion and ſolid extenſion; for that conſtant action is the baſis of its exiſtence: and here I perceive again it could not fall under the ſenſes, unleſs the ſame power were farther exerciſed upon theſe particles, to bring them by another act within the reach of ſenſible perception. And certainly this is wonderful, that, let us conſider matter which way ſoever we will, we meet always with the power of the Deity; and the more ways it becomes known

to us, the more acts of that power we diſcover.

P. Your reflection is pertinent, Matho, and it muſt be as you ſay. If we could conſider the Deity in himſelf, and abſtractedly from what he hath produced (as we attempted in our laſt conference) we ſhould find his nature and perfections neceſſary and infinite, and be every where prevented with the ſight of them: and when we conſider his effects aright, we muſt find his power and knowledge in every thing, examine it which way we will.

LIX. *M.* The ſeveral ſpecies of things you have mentioned are formed within the bowels of the earth.

P. Or at leaſt below its ſurface; and though they are not produced from ſeeds, like vegetables above ground, yet ſome of them come near enough to ſhew almoſt the ſame work in different ſubſtances. One ſpecies of thoſe ſtones, called (I think) *ſtalactites*, in ſhape like the ſlender ſtem of a young plant, broke any where up or down, hath always the ſame ſtar-like figure or impreſſion in the heart; as when you cut a plant above or below the fibres make ſtill the ſame appearance in the ſection. The ſame is obſerved in the ſeveral ſorts of *coral*, which ſeems to be of a middle nature indeed, between a plant and a ſtone.——

M. Permit me to aſk you what is contained within the bowels of the earth; or is it known what the whole maſs, down to the center, conſiſts of?

P. It is not known: the deepeſt *mines* go but a ſmall way below the ſurface, and after that all is conjecture.

M. We cannot know then what this globe we

live upon contains for four thouſand miles down.——What do they find in the mines?

P. Different ſorts of *earth*, *ſtone*, *coal*, &c. lying in *ſtrata*, one over another, with here and there the *ores* of metals.

M. Theſe are not matter in its original form.——What ſort of matter do they conjecture to be from that to the center?

P. They ſuppoſe that the ſolid cruſt of the earth is not very deep; and ſome have thought that the internal part is a ſubterranean ocean, while others imagine that there is a vaſt maſs of fire about the center. It hath been ſuppoſed, in order to account for a difficult appearance in philoſophy, and to avoid the thought of ſo much dead matter, that the internal part of the earth conſiſts of *vacant ſpaces* and *cruſts* alternately.

M. Theſe conjectures are oppoſite enough, ſo that the probability for any one of them muſt be an argument againſt the reſt.

P. This is but one particular of many, which lie without our reach.

M. Leaving it then, you ſeem to think that all vegetables above ground riſe from ſeeds?

P. That was long matter of enquiry and diſpute; but it is now allowed to be true in all caſes, univerſally.

M. Why was it matter of diſpute?

P. If a plant could riſe from any but a ſpecific ſeed, then it might be contended that any thing could riſe from any thing, which muſt have bad conſequences in philoſophy.

M. I underſtand; it is ſuppoſed that theſe *ſpecific ſeeds* keep the ſpecies regular.

P. This is the conſtant experience of mankind: a *fir-tree* does not riſe from an *acorn*, nor

nor a crop of *wheat* where *barley* was ſown.

M. That would certainly breed the laſt degree of confuſion and diſtreſs to mankind; and we cannot ſufficiently adore that wiſdom which hath ordered things otherwiſe. Yet I have ſeen the root of an old tree, where the trunk had been cut off, quite covered with excreſcences, differens from *muſhrooms* or *toad-ſtools*, with a variety of pretty bright colours. Theſe certainly vegetate, and yet they have neither *flower*, nor *fruit*, nor *ſeed*; but ſeem to ſpring up from the corruption of the decaying wood.

P. The firſt degree of vegetation, Matho, is ſo fine, that it is hard to trace it out, though above ground. You know we are ſoon loſt in the ſubtlety of nature's operations. Hence it is that ſome ſpecies of imperfect vegetables impoſe upon the inattentive, and paſs for mere anomalous excreſcences, though they are nothing leſs. The ſpecies of *fungi* (as they are called) are very numerous: it was one ſort of thoſe which you obſerved. The ſtructure of ſome kinds of them is altogether curious, as you muſt have ſeen: and the diligent enquirers into nature have at length diſcovered that they riſe from a ſeed, and are not ſpontaneous productions from decayed wood, or any ſort of corruption, though they draw their nouriſhment from ſuch things.

M. I have indeed obſerved ſome of the broader ſort with flat thin caps, finely wrought below, having a ſlender kind of leaves, running very regularly from the middle to the extremity, like the rays of a circle: but theſe ſeeds muſt be very ſmall, which require ſuch attention to be diſcovered.

P. This is not the only inſtance where the firſt degree of vegetation runs almoſt beyond our ken.

Wherever the ſeeds were not perceptible to the naked eye, the ancients ſuppoſed the productions from them ſpontaneous and irregular: but the invention of the *microſcope* has enabled the modern enquirers to make noble diſcoveries in the works of nature, though ſtill the ſubtlety of the contrivance goes deeper than the induſtry of man can penetrate. So ſmall are thoſe ſeeds, that it is to be doubted whether many ſorts of them are not conſtantly wafted up and down in the air; ſince they ſo quickly take root, and ſpring wherever they can find a ſoil delicate enough. For it has been diſcovered by the microſcope, that the mouldineſs which appears on ſpoilt confections, pickles, or even ſome ſorts of liquors, by which they appear as if covered with a white cruſt, are only numerous cluſters of diminutive muſhrooms.

M. This is really ſurprizing, and carries the beginnings of vegetation almoſt out of our ſight indeed. What you ſay of a white cruſt puts me in mind of another particular I have often obſerved, and endeavoured to account for to myſelf, though in vain. Pray what are we to think of the ſeveral *coloured cruſts* which we find on ſtones, and the bark of trees? On the ſame ſtone, or the bark of the ſame tree, you will ſee ſpots of *white cruſt*, of *black*, of *greyiſh*, and very often of *yellow*. At firſt they are very hard, and ſeem little other than a colour inherent in the ſtone; afterward they ſwell and riſe.

P. Theſe, Matho, are ſeveral ſorts of *moſſes*, which you may know by their different growths: for if you obſerve on the ſame, or different ſtones, you will ſee the ſame ſort young and hard, more advanced, and at laſt ſpread, when their ſeveral figures are eaſily diſtinguiſhable by the naked eye.

Some

Some ſpread in a continued leaf, others grow hollow above like ſmall cups, others round on the top like muſhrooms, and ſome ſhoot out in branches.

M. It is ſo indeed; theſe varieties, and many others, I have often obſerved with great admiration: for I remember this was the firſt thing that raiſed my curioſity.

P. All theſe have their different ſeeds, which do not require great delicacy of ſoil, but take root on any thing where they can grow unmoleſted. Thoſe *moſſes* which riſe immediately from the earth, are more perfect, ſome of them white, and hollow, or fiſtulous, and ſome of them not much inferior to regular plants.

M. There are much perfecter ſorts which grow likewiſe on ſtones, in the form of a fine pile or furr, like velvet, and of a gloſſy colour between green and black. But the firſt ſort, which appears like ſcurf or cruſt, ſeems to riſe but one degree above the unwrought mold or earth.

P. Yet we are far from being certain that this is the loweſt degree of vegetation.

M. Thoſe moſſes growing on trees ſhew, I think, that their ſeeds muſt fly about in the air.

P. We ſhall become too minute at this rate, Matho: however, what you ſay is more than bare conjecture: for ſome experiments ſhew that living creatures themſelves float thus up and down in that element. An unhealthy tree is never without theſe imperfect *ſuper-plants*; and the more unhealthy the tree is, the better they thrive.

M. It ſeems, as ſome animals can only live on other animals, and have not a ſeparate way of ſupporting themſelves; ſo ſome imperfect vegetables can only thrive on other vegetables.

P. There is ſome analogy between the inferior vegetables and animals in this reſpect: and there is (if I might ſo ſay) a ſtudied variety through all nature: but ſome much perfecter plants than moſſes can only take root on a tree. You certainly remember theſe lines,

Quale ſolet ſylvis brumali frigore viſcum
Fronde virere nova——
——quod non ſua ſeminat arbos.——

M. I was told of the *miſletoe* at that paſſage. However,

LX. One thing you ſaid above ſurprizes me more, viz. that any vegetable ſhould take root in mere liquor, as thoſe little muſhrooms you ſpoke of.

P. The fact is, nevertheleſs unqueſtionable: two or three ſorts of plants ſtrike their roots in the water, without touching the ground at all; and, as a proof of this, they float to and fro on the pools where they grow.

M. This is a ſingular inſtance of variety.

P. As many ſpecies of animals can only live in the waters, ſo many ſorts of plants can only thrive in that element, though their roots are fixt at the bottom; and of thoſe ſome never riſe to the open air. Some kinds of plants alſo, as well as animals, are amphibious, and can live either in or out of the waters.

M. By the weeds caſt out on the ſea-ſide, the ſalt water ſeems likewiſe to have its peculiar vegetables.

P. And that in great variety; nor ſuch only as deſerve the name of *alga*, but ſhrubs and larger trees, with ſome of which near the iſland of Crete they uſed to dye purple. Pliny tells us, that in the *Indian* and Red Sea are whole ſub-marine woods.

In

In the Perſian and Red Sea, and many other parts, coral is produced, of which we ſpoke before. Under water it is ſoft, but petrifies in the air. But the nature of marine plants is not ſo well known, as thoſe on the dry part of the globe; as not being ſo acceſſible, nor to be trained up in different circumſtances.

M. Hence, I ſuppoſe, the greateſt variety muſt be on dry land, where there is a greater difference of ſoils.

P. You ſee the whole face of the earth is covered with them, as with a large and coſtly carpet.

M. The carpet is very large indeed! and a new one ſpread every year with more variety of figures and colours than the *loom* or *needle* can boaſt. We do not think enough on theſe things. A bare and naked earth muſt have an unpleaſant ſight.

P. Not more unpleaſant to the eye, than unfit for habitation. We might have lived as comfortable on a globe of marble, as on ſuch a naked and barren globe. We obſerved before, that the diſpoſition of the ſurface into hills and valleys was for the ſake of ſweet and running waters, which only regarded the animals and vegetables upon the earth. The ſea itſelf, that huge magazine of waters, was chiefly intended for the dry part of the globe; though at the ſame time it ſerves for many other wonderful uſes, and is beſides a mighty nurſery of living creatures. Hence it is, ſince this *element* is ſo abſolutely neceſſary for animal life and vegetation, that it bears ſo great a proportion to the dry land. Some philoſophers likewiſe, with a great degree of probability, ſuppoſe, that this article of vegetation occaſions a conſtant expence and conſumption of

water. Which ſhews us, that this great proportion of the liquid to the dry part of the earth was ſtill more wiſely appointed.

M. I have in truth often wondered, on looking at a map or a globe, to ſee ſo much of the ſurface of the earth covered with water: but this accounts for it naturally, or rather makes this diſproportion between them neceſſary.——But pray let me aſk you here again, if it be known how deep the ſea is?

P. You may be ſure it cannot be all of the ſame depth. Iſlands and rocks are generally ſituated near the coaſts of the larger continents; which ſhews that the ſea is there but of a moderate, or rather ſmall depth. In withdrawing from the land it becomes unfathomable: hence it is natural to ſuppoſe that in the midſt of the large oceans, as the Atlantic, Ethiopic, Pacific, and Great South Sea, the depth is greateſt. But what the diſtance of the ſurface of the water there from the ground below may be, is not eaſy to be determined. There is not the ſame reaſon for an equal declivity from the coaſts to the middle of the ocean, as from the middle of the continents to the coaſts: yet poſſibly the ſea there may be ſome miles deep.

M. Who hath hollowed out ſuch a *mighty baſon*, and *filled* it with ſo uſeful a fluid! All the great rivers on the earth themſelves, like gliding oceans, were conſtantly to be drawn from this vaſt repoſitory of waters.

P. And drawn through the air too, to the tops of the higheſt mountains, where they were to begin their return over the face of the thirſty ground. And this circulation was to be maintained through all ages. The vapours are raiſed

by their ſpecific lightneſs, and mutual repulſe; till coming to a colder region, where their repellent force is weakened, they are brought again into ſmall drops, which fall by their own gravity. Whence we ſee that the whole terraqueous globe, ſea as well as dry land, taking in the whole region of the atmoſphere, was contrived for the ſake of vegetation, as the firſt and immediate uſe; though vegetation itſelf is ſtill referable to a higher deſign. Upon this account it is that no part of the dry ſurface is vacant and unemployed. Not only the *plains* and *valleys* are delicately clothed, but the *wild mountains* have their rougher vegetable covering. Vegetation and animal life go together, and in the deep winter languiſh together. The ſtately and noble plants, which rear their heads aloft, are perennial and long-lived, like ſome animals; but more ſorts of both are of a ſhort and tranſitory duration. The *inſects* revive with the verdure of the ſpring: every ſeaſon of the year brings forth a new variety: every ſoil and different climate have their peculiar ſpecies, both of vegetables and living creatures. As the diverſity of the ſeveral ſpecies is aſtoniſhing, ſo the fecundity of the individuals is no leſs ſo. Were all the ſeeds of any of the moſt uſeful plants employed annually for vegetation, that alone in a ſmall number of years were enough to cover the whole ſurface of the globe. Learned men have ſhewn the ſame with reſpect to many animals, eſpecially in the waters. But the almighty author of proportion preſerves a juſt balance, and diſpoſes the ſuperfœtation of his creatures to neceſſary purpoſes. The *exuberance* ſhews his power, and the *application* his wiſdom and goodneſs.——Theſe are only general things, Matho, which it is eaſier for any

one

one to admire in his own thoughts, than to make worth another's while to hear. You ſee my willingneſs; nor can any words repreſent what an attentive mind may eaſily obſerve. To ſay any more would but anticipate your pleaſure.

M. You have rather given me a noble proſpect, Philon, of the productions in and about our habitation. The bowels of the earth ſeem to be a vaſt *laboratory*; the ſurface of it is wrought into a beautiful and ſpacious *garden*; the ocean its *fountain*, and (if I durſt go farther) the air a mighty *watering engine*. If we look above and below ground, the ſame common matter is formed into ſuch a diverſity of bodies, as if they were wrought from ſubſtances of contrary natures. A plant and a mineral, or metal and an animal body, or (to come yet nearer) the ſtone and the fleſh of the ſame peach, ſeem not to be matter in the ſame ſenſe. But aſſure yourſelf we are far from having done. I have many queſtions to aſk; every thing you ſay raiſes new thoughts in my mind, and one particular above I either did not underſtand, or am not ſatisfied with.

LXI. *P.* What may that be?

M. I believe no young perſon of ten thouſand ever ſaw a field of corn grow, without admiring the miracle of propagation from ſeed, and that inconceivable *fecundity of individuals* which you mentioned juſt now. This is one of thoſe things which firſt ſtrike the young and inquiſitive mind with wonder; and how the regular obſervation of the ſpecies is owing to the ſeeds of things, I do not yet underſtand: but I ſhall proceed to aſk you my queſtions by degrees.——If one ſingle grain of *wheat*, or any other ſeed, were ſown, and the

product of it preſerved and ſown; and the product of that again preſerved and ſown, and ſo on; how far do you think it would multiply? Or would there be any end of its increaſe?

P. According to the courſe of nature, we have no reaſon to think it would ever ceaſe to multiply.

M. So I have often thought; and according to what you ſaid, it muſt in time be ſufficient to cover the whole face of the globe. Now how comes this infinite number of plants and ſeeds all to ſpring out of one ſmall grain?

P. That is a queſtion I can by no means ſolve. It ſeems to me to carry the ſubtlety of vegetation far out of human ſight. And what heightens the difficulty is, that the ſeed, in ſome caſes, is diſcovered to contain in miniature the plant that riſes from it, with ſo much nouriſhment wrapt up in it, as may ſerve to its firſt vegetation, till it can ſtrike root in the ground, and draw its farther ſupport from thence: and from this it is concluded that all its future vegetation only nouriſhes and increaſes the parts of this ſeminal plant.

M. That conſideration indeed makes the propagation of ſuch an infinite number of plants and ſeeds, all from one little ſeed, above meaſure aſtoniſhing. But what have the *ſearchers* into the myſteries of nature thought of this?

P. It is really a *myſtery*; however, ſome have had recourſe to the infinite diviſibility of matter to explain it, ſuppoſing that all the infinite individuals of any ſpecies, whether of vegetables or animals, were actually contained in the firſt original ſeed.

M. And how came this *infinitely impregnated original ſeed* to exiſt?

P. You preſs me too far.

M. Since,

M. Since, according to the courſe of nature, the propagation from any of theſe *propagated ſeeds* is indefeaſible, each of theſe muſt likewiſe be *infinitely impregnated?*

P. It muſt on this ſuppoſition.

M. Did they reſt ſatisfied with this explication?

P. They could not, I think, otherwiſe than by having recourſe to the conſtantly operating power of an almighty being. And it is thus, in my judgment, that the origin of any thing muſt lead our baffled reaſon to ſeek a ſolution of difficulties in *omnipotence.*

M. If we are forced to have recourſe to the conſtant operation of that power, this ſuppoſition ſeems needleſs. But is this all that has been ſaid?

P. Others have ſuppoſed that the greateſt part of the *terreſtrial maſs*, at leaſt near the ſurface, conſiſts of the ſeeds of things, ready wrought up, and perfected, which are impaſſible in all the changes that happen, till they come, in the courſe of things, to be brought into the circumſtances of growth and vegetation: and that there is no more rude and unwrought matter in the maſs, than what may ſerve for a ſupport to that which is deſigned for future plants and vegetables: for I am not ſure if they include animals in this ſuppoſition.

M. And yet if animals be not included in it, they will have another ſuppoſition to make for theſe, ſince there is the ſame difficulty in both caſes. Here it is not enough to ſuppoſe the ſeeds of all things finiſhed and wrought off at once, and repoſited any where: it muſt likewiſe require infinite care and direction, to produce theſe little impaſſible ſeeds in their proper time and place, without confuſion or miſtake, according to the

ſettled

ſettled law and courſe of nature, ſince they can do nothing of themſelves.

P. It is certainly ſo.

M. Though then there were ſuch *original immutable atoms* repoſited, which contained the ſeminal power, or were deſigned for the future ſeed, yet when a grain of *barley*, for inſtance, is ſown, and begins to ſpring up, what directs the *ſpecific atoms*, deſigned for that ſeed, to it, rather than the *atoms* deſigned for *wheat*, *rye*, *oats*, or, in ſhort, for any other grain? Or could the ſettled courſe of things be obſerved, if one grain roſe where another was ſown?

P. As you obſerved before, that muſt breed the laſt degree of confuſion.

M. There are likewiſe many things to be done, I preſume, after the firſt *ſpringing up*, before the future ſeed is formed: for let us conſider a *field of corn*, a *meadow*, an *orchard*, or, in a word, the whole face of the earth, as covered with vegetables; and is not every grain or ſeed that riſes over the whole, once in the form of a green blade or leaf?

P. At firſt it is, or in the form of ſomething as different from the future ſeed, as a green blade is.

M. And after that, I preſume, in other forms ſtill, as the ſeed draws nearer to a perfect formation?

P. It is indeed in the form of *ſap*, or of a *bloſſom*, or *flower*, or *milk*: for all the particles are once, or rather always in a liquid form, till the ſeed comes to be hardened.

M. What hand then, or whoſe art brings this ſeed, whether in one atom, or ſeparate particles, through all theſe various forms and changes?

P. It is impoſſible to account for this, Matho, without the immediate power of the Deity, ſince the ſluggiſh particles can neither move, nor aſſemble themſelves from different parts, nor fall into that conſtant change or order, which is requiſite to their coming out at laſt in the deſigned form, or ſo as to make up the ſpecific ſeed.

M. If then the power of the Deity muſt be immediately concerned in all this *various work*, we need not, I conceive, be ſo anxious to find out, all at once, an original ſtock of ſeeds, to ſerve for future vegetation through all time.

P. In theſe caſes we find out a *compend* for the Deity, only by our own miſtake; ſince after ſuch ſuppoſitions the indefinent operations of his power and wiſdom are ſtill neceſſary. Matter is as much a dead reſiſting ſubſtance in *vegetation*, as in the motions of the heavenly bodies.

LXII. *M.* This likewiſe ſeems wonderful, that from the ſame *mold*, and the ſame ſort of *fluids* or *juices* (as I ſuppoſe) ſo many different ſorts of vegetables, and ſuch different kinds of bodies on the ſame vegetable, ſhould ariſe. In a ſmall ſpot of ground you ſhall ſee a great variety of *herbs*, *flowers*, *trees*; and belonging to the ſame tree a great difference of productions, *leaves*, *bark*, *wood*, a *mellow fruit*, a *hard ſtone* within, or perhaps a *ſtrong ſhell* without. Has each of theſe ſubſtances a different ſeed? Or will it be a ſatisfactory explication, to ſay that the original ſeed contains leaves, bark, &c. in itſelf?

P. Leaves and bark are but excrementitious parts of a plant.

M. Yet they are as ſpecifically different from the leaves and bark of another plant, as the wood,

or fruit, or ſeed itſelf. Account for this ſpecifical difference of theſe parts. You muſt either account for every difference from the ſeed, or give up the pretence of accounting for any thing from it.

P. Each ſort of plant, they ſay, draws juices proper only to its own ſpecies.

M. What is meant by *drawing* here? In plain language it ſeems to be as good as ſaying, *each ſort of plant forms itſelf.*——But when ſeveral kinds of trees may be grafted on the ſame *ſtock*, they ſeem to have but one kind of juice to draw. And yet the fruit of each ſort preſerves the particular colour, taſte, ſmell; and the leaves and wood remain with the ſame differences from others as before. What is ſaid to this?

P. I know not whether any thing be ſaid to it.

M. To ſay the *ſtock* draws to itſelf the ſeeds of every other tree that might be grafted upon it, and bear ſeed, would be to ſuppoſe that every ſort of plant draws to itſelf the ſeeds of all other ſorts. And unleſs we will take the liberty of talking at this rate, the matter of fact ſeems to ſhew that there are no ſuch ſeeds wrought off before-hand, and lying ready prepared; but that they are formed every ſeaſon, as much as the fruit or leaves.

P. That is the more tenable opinion.——

M. And then, though ſeveral ſorts of animals were fed with the ſame ſpecies of grain, or with hay of the ſame field; that would not make their fleſh taſte all alike: beef would not turn mutton, nor pork fowl, in ſuch a caſe.

P. There are certain *ſecretory glands*, which have the orifices or mouths of their veſſels ſo fitted, as to admit only ſuch particles for nouriſhment as are of a particular ſize, and proper or ſpe-

cific

cific for the plant or animal, or the part of any of theſe which is to be nouriſhed, and which therefore repell or throw off particles of a different ſize.

M. Theſe things are new to me, Philon; but I believe there muſt be ſuch contrivances in the animal body: yet, if thoſe glands are nothing but matter, they can no more be the cauſe of the ſpecific differences we are ſpeaking of, than an *artiſt*'s tools are the cauſe of his art, of which they are only the inſtruments. There muſt be a higher principal than *orifices* and particles of ſuch a determined ſize. For if theſe orifices, or the texture of the gland, be fitted to receive particles of a larger ſize, how are thoſe of a leſſer kept out? If to admit only particles of a leſſer ſize, how can theſe get in? Since the larger coming up along with them would naturally ſtop or obſtruct theſe orifices. And if both ſorts come not up together, the *ſecretion*, I think, was made before. And what is ſaid of the *magnitude* of particles, is true alſo concerning their *figure*: orifices, or paſſages deſigned for receiving particles of one ſort of figure, muſt be obſtructed by thoſe of another figure coming up along with them.——Beſides, how come the various particles thither? For as to *repelling*, or *throwing off*, which you mentioned, it is like the plants *drawing* proper juices to them. Attraction and repulſe are not the work of inert particles. I remember you ſaid the quantity of motion once impreſſed is conſtantly decaying by the action of matter upon matter. In this caſe therefore the impreſſion muſt be renewed on theſe particles every moment: or rather, they muſt be conſtantly impelled, and that in various directions, but not by the power of matter.

P. We

P. We are agreed, Matho, no man ever had a notion of ſecretion purely mechanical. The admirable ſtructure of theſe glands or ſtrainers, and of every other part in the animal body, is only *inſtrumental*; but can no more ſupply the *power* in a living, than in a dead animal. The mind of man is ingenious to deceive itſelf. Seeing no other *power* or *direction* near at hand, to which we can have recourſe, we ſuppoſe that the matter in the animal or vegetable body muſt have all thoſe powers in itſelf, neceſſary to account for ſuch wonderful appearances. But the growth and vegetation of all things round us (not to ſpeak of the work in the animal body) is a conſtant, various, and infinite miracle.

LXIII. *M.* This anſwers my expectation, and agrees with what we have obſerved in the reſt of nature. But tell me, before we leave the ſubject, why ſhould ſuch ſtreſs be laid upon vegetables riſing from ſeeds? Let the ſeed contain the future plant ever ſo exactly, yet when the ſeed itſelf and the contained plant are formed, they paſs through various changes, by a power quite above that of ſluggiſh matter: they are wrought from different ſubſtances, and often from the ſap and juices of a tree of another nature. The ſeed therefore contributes nothing at all to the regular continuance of the ſpecies of plants (and poſſibly I might ſay animals) more than the plant contributes to the regular continuance of the ſpecies of ſeeds. The two caſes ſeem exactly alike: both formations are the effect of a different cauſe; though the one is appointed [arbitrarily] to follow the other, as a ſettled courſe of nature.

P. Since the atheiſt contends that all things

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ſpring up ſo ſpontaneouſly at firſt, and therefore that any thing might riſe from any thing; it is a point of ſome conſequence, Matho, to ſhew him that a plant only can riſe from a ſpecific ſeed, and a ſeed only can be produced from a plant, even in the loweſt vegetables. This is a conſtant matter of fact againſt him. But I am afraid the generality of men go too far, in ſuppoſing that the regularity of the ſpecies depends upon the ſeed: whereas you have ſhewn very well, that the future plant no more depends upon the ſeed, than that ſeed depends upon the former plant. The argument thus ſtated and cleared, ſhews that there could not have been an eternal ſucceſſion of ſeeds and plants, nor of *father* and *ſon*, for the caſe is the ſame. This alſo has been contended for, and called an *eternal ſucceſſion of cauſes and effects*. The ſeed is neither the cauſe of the plant, nor the plant of the ſeed. It was a true obſervation which you made at your firſt coming in, "That the courſe of nature, and ſubtlety of "things, muſt reſt upon a ſurer foundation than "dead matter." In reality a plant is formed from various parts of matter *not a plant*; and a ſeed from various parts of matter *not a ſeed*. This ſhews the abſolute power of the Creator over matter, and that he is the immediate cauſe of the production in both caſes. But he hath appointed the one production to follow the other alternately, that there may be a ſettled courſe of nature, and that man may know what he has to do. In a word, we reaſon but by halves with the atheiſt, when we ſhew him that all vegetables riſe from *ſpecific ſeeds*, unleſs we likewiſe ſhew him that theſe ſeeds are the immediate work of *almighty power*. Without this, theſe ſeeds have only the

appearance of *moulds* and *forms*, for the atheiſt to direct his work by, leſt he ſhould happen to blunder.

M. You have expreſſed this affair to my ſatisfaction.——And if after this we conſider the *various action* in the growth and vegetation of bodies, by parts only, or in the more ſimple caſes, and ſtill riſe from the individuals to the ſpecies, till we have taken in the whole vegetable kingdom, which makes a rich and beautiful covering for the whole face of the earth; and if we take into the account the numerous tribes of animals that are in the waters, on the dry land, and in the air; the inſtances of power and wiſdom manifeſted in theſe appear to me more aſtoniſhing (if I durſt ſo ſpeak) than what we admired in matter in general, and in the great bodies of the univerſe.

P. Eſpecially if we admit into the reckoning, that in every ſpecies of vegetables and living creatures, a different and new artifice is employed: for (as you ſaid) the art is ſtill heightened with new additions and variations, as it were to guide us from the more ſimple to the more complex wonders by eaſy ſteps. But this is perfectly as it ſhould be, Matho: the artifice and variety of contrivance muſt (to our conception) be greater in matter, as wrought into vegetables, and the bodies of living creatures, than when rude and undiverſified by workmanſhip. This is agreeable to what was ſaid, *That the coarſeneſs of the ſtuff lies concealed under the variety of art; and the very deadneſs of matter is diſguiſed with a thouſand beauties of life and vegetation.* I know what paſſes in your mind on the conſideration of theſe things, by what paſſes in my own. The mind would fain purſue each particular ſeparately, till it

it has admired the wonders apart: but admiration itſelf is ſoon overpowered, and ſinks into undiſcerning amazement. Even this is pleaſant. The time will come——And yet after all, what you obſerved in another caſe is true here: whatever we conſider at the time muſt appear to us moſt wonderful, becauſe our faculties are every where overcome by an infinite exceſs of art and power, which therefore we cannot compare.

LXIV. *M.* The mind brought to this impotence of thought muſt turn away the view, and change the object.——You make the ſame diſtinction, I ſuppoſe, of *perfect* and *imperfect* among animals, as among vegetables?

P. Every ſpecies of living creatures is perfect in its own kind, conſidered in itſelf; becauſe exactly fitted to its own way of life, and all the ends of its exiſtence: but if compared with higher ſpecies, it may be reckoned imperfect, as you yourſelf obſerved before of the *earth-worm*, compared with ſome other reptiles. It is this comparative imperfection which ſhews us the continuation of the ſcale, and ſeries of the works of nature above rude earth. The lower ſort of vegetables border (as you ſay) upon the unformed mold; and in their firſt appearance look like *ſcurf* or *ruſt:* yet from this low beginning the ſeveral ſpecies of plants riſe, till ſome of them mimick a degree of ſenſitive life, ſhrinking up, or contracting their fibres on the ſlendereſt touch. Here the animal kingdom begins; for ſome creatures, as the *oiſter* and *muſcle*, are like plants, rooted to the place where they were firſt bred. Theſe ſeem to have but one, or two ſenſes at moſt, the *taſte* and *touch:* for as they are fixt to the ground,

ground, they have no occasion for *hearing*, or *seeing*, or *smelling* objects at a distance, nor for difference of sex.

M. Animal life is here indeed very low, and seems but one degree above the plant, which, you say, contracts its fibres on being touched.

P. As sensitive life is here much confined, so spontaneous motion is in the lowest degree we can well imagine; the creature having only the power to open its shells for receiving the food which is washed to it by the waters, and to shut them again. Yet this sort of life is heightened by various steps in each successive species, till at length the *sensitive perfection* in some species, as the *dog*, the *monkey*, the *ape*, borders upon human reason. There is such a diversity in this, as well as the former part of the scale, as we cannot enough admire. No man of the most extensive invention could consistently devise a variety, which does not exist; nor, without having seen them, conceive the differences that are. Hence the transitions are natural and easy. Every middle species has a connexion with that immediately above or below it, or something that is common to it with both. Thus a continued relation, or affinity of art and contrivance, runs through the whole, till it reaches *man*, who is at the head of the visible part of the series.

M. Doth not the scale end where it ceases to be visible?

P. There is no reason to think it does, unless we thought the soul of man the most perfect living being next to the Deity.

M. That thought would be rash, since there is such an infinite distance between these two. But is there not a gradation of perfection in the *living*

part, as well as of art and contrivance in the bodies of animals?

P. It is not ſo eaſy to ſpeak on that ſubject, Matho; and the leſs eaſy as it falls in with a point which has always been much controverted. Thus much we may ſay with certainty, that as there is a great difference between the talents and ſagacity of one ſpecies and another, ſo this difference cannot be aſcribed to the different formation of their bodies.

M. You almoſt ſatisfy me already. *Matter can impart no power nor perfection.* The arts of ſome creatures are inimitable, either in hunting for the prey, or avoiding the purſuit: and it is but reaſonable to allow that the different contrivance and formation of the body is rather fitted to the different talents and endowments of the living part of brute animals. But what name will you give to that principle, by which brutes perform ſuch ſurprizing things, if you do not allow it to be called a ſort of reaſon in them?

P. The firſt principle which directs *many* actions of all animals, and *all* the actions (I believe) of the lower animals; and which is the ſtrongeſt and moſt wonderful connexion between the vegetating and animated parts of the creation; is much perfecter than human reaſon: while the principle which properly belongs to the brute-mind is much inferior to the reaſon of man.

M. This is all riddle: pray what is that principle which governs the actions of the lower animals, and yet is perfecter than the reaſon of man?

P. To tell you it juſt now, would be equal to begging the queſtion of you: but if from conſidering appearances you diſcover, and are

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forced to own it firſt, I ſhall not be obliged to you for allowing a thing which you cannot deny.

M. I leave the method to you. But are there no other connexions, beſides *this*, between the vegetating and animated parts of the creation? You ſaid before, *That vegetation itſelf is referable to a higher purpoſe.*

P. If the earth had not been productive of vegetables, it could not have been repleniſhed with animals. Thus the lower order of things is referred to the higher; and in this ſenſe the common expreſſion, *All fleſh is graſs*, ſeems to be literally true.

M. And if there had not been variety of vegetable productions, there could not have been ſuch a variety of living creatures.

P. Abſolutely ſpeaking, the *laſt* of theſe does not depend upon the *firſt*. Infinite power is not to be circumſcribed. But you obſerved, that *infinite power is conducted by infinite wiſdom.* Had there been but one ſpecies of each kind, we ſhould have wanted innumerable inſtances of the power and knowledge of the Creator. Hence in the ſettled courſe of nature the variety of animals is connected with the variety of vegetable productions. Different ſorts of *plants*, *herbs*, *flowers*, are appointed for food to the ſeveral tribes of animals. That was to be hurtful to one ſpecies, which is ſalutary to another. One creature climbs the higheſt rocks for herbs, another digs in the earth for roots, and we ſcarce know a plant or leaf, but what affords nouriſhment and a place of nativity to ſome tribe or other of the leſſer inſects, of which there is by far the greateſt variety in nature. This is the foundation of innumera-

ble *relations* and *connexions* between theſe two parts of the creation; which ſhews the work to be *one*, and the deſign of the ſame power and wiſdom. If we could make the horrid ſuppoſition, that chance had produced the world, yet what conſtant *errors*, *blunders*, *miſapplications*, muſt there have been! Every thing muſt have been monſtrous, and ſuch an harmonious ſyſtem of things infinitely impoſſible.

M. I ſee a beauty from this article of food, which I was not aware of. There muſt be a precontrived relation and fitneſs between the internal conſtitution of the animal, and the nature of that herb or plant, which affords it nouriſhment: this opens to us a hidden ſcene of contrivance running through all nature.

P. Hence the deſign and uſefulneſs of thoſe *effluvia*, or *ſcents*, conſtantly emitted by all ſorts of vegetables: theſe gratefully affecting the olfactory nerves, invite the related tribe to their proper food; or contrarily.

M. Solicitous proviſion of the Deity! Methinks I ſee every herb of the field pouring out a conſtant ſtream of ſubtle vapour! Without this minuteneſs of care, the animals might as well have devoured what was baneful, as what was ſalutary.

LXV. *P.* As the living part of the creation was to riſe higher in variety than the vegetative part, innumerable other relations and congruities appear to us, from the article of food and nouriſhment, between the animals among themſelves.

M. That I do not apprehend.

P. All the inferior animals were to be but ſhort lived; their dead carcaſſes were to fall, and

lie upon the earth: their ſuperfetation therefore, or the increaſe above what is neceſſary for keeping up the ſpecies, is appointed for a farther uſe, namely, to be the food of other animals.

M. This I underſtand from what you ſaid a little before, *That the almighty author of proportion preſerves a juſt balance amongſt his creatures, by diſpoſing the ſuperfetation to a farther purpoſe.* And ſurely, to our apprehenſion, it had been eaſier to prevent, than effect ſuch a ſuperfetation; for what was neceſſary to keep up the ſpecies, muſt have been but ſmall, in reſpect of the preſent multiplication.

P. From this, innumerable other relations and aptitudes, both in the bodies and living parts of brute creatures. Thoſe which are deſigned to live on animal food, have (as you obſerved) an inimitable ſagacity in diſcovering, and the very fitteſt diſpoſition of parts for catching the prey allotted to them. Nor, on the other hand, have the weaker animals fewer arts and wiles for eluding the purſuit. Here art tallies to art; and ſagacity to ſagacity. Every creature knows, without being taught, where it is wanted for food, and the animal by which it is thus coveted.

M. This I conceive eaſily, and could give you an inſtance of it from my own obſervation. I have watched the motions of a *ſpider* for whole hours together, and have ſeen when he durſt not attack a larger *fly*, though entangled in his nets, 'till he had gone over and over it many times, and at each time had drawn a new thread round it; 'till at laſt it was quite wrapt about with his chains, and defenceleſs. But I hate the ſpider; he is a bold, cunning, mercileſs enemy.

P. It is very right to hate the image of cruelty:

yet the *ſpider* is juſt as cruel here, as the *ox* which eats the graſs of the field, or the *caterpillar* which devours the green herb. Cruelty ſuppoſes injuſtice, and injuſtice a knowledge of *right* or *wrong*, which irrational creatures have not. Cruelty is the deformity of rational beings, and neither of the *lion* nor the *tiger*.——

M. I am afraid I am wrong, and ought to change my way of thinking a little; for I ſee an unanſwerable ſtrength of reaſon in what you ſay.

P. I do not ſpeak thus, Matho, with a view to defend a ſanguinary diſpoſition in mankind; I ſhould then contradict reaſon and humanity; but to aſſiſt you as far as I am able, to a conſiſtent way of thinking, concerning the works of the Creator. Men firſt make brutes rational, and then cruel; and then there is an example of high authority ſet for the *tyrant*, the *ruffian*, and *mercileſs oppreſſor*.

M. I ſee the uſe that might be made of this miſtaken notion.

P. Nor is this the only bad uſe that is made of it.——A *mere ſenſitive creature*, whoſe ſenſes are gratified, is complete in its kind, and in the ſcale of beings, and has nothing to complain of, though it is not immortal: but we furniſh it with *our reaſon*, and then the complaint, which is made in its name, paſſes with moſt people for reaſonable. Gluttony and pampering are ſhameful and unmanly vices, above the poſſibility of being juſtified: yet I think it looks as if thoſe who affectedly rail at mankind, for living in the continual butchery and ſlaughter of the inferior animals, intended the invective higher; or, how will they pretend to accuſe man, and clear the Creator? This is not the place to conſider, what pain

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an unreflecting animal may feel: it is not the ten thouſandth part of what a rational creature muſt ſuffer in like circumſtances (anguiſh and diſtreſs of mind cut deep every moment;) and it is a pain that muſt be multiplied by the infirmities and languiſhing of unprovided old age. In ſhort, if thoſe nice folks had no other meaning but commiſeration to the inferior animals, they ought never to ſtir abroad, nor tread upon the ground, but with the greateſt caution, for fear of taking away the life of ſome little harmleſs creature. Let them ſuppoſe that there were no carnivorous animal in nature; and in conſequence of that, they muſt ſuppoſe that the ſpecies and individuals, which live on vegetables, ought to have been incomparably fewer; and therefore that the ſpecies of plants and vegetables ought to have been fewer in proportion. And if the immediate uſe of *this globe* were for the production of vegetables and animals, that ought, likewiſe, to have been ſhrunk into leſs dimenſions. And having thus broke the ſcale and proportion of nature, let them try how they could mend it again, and give us one of their own faſhion.

M. From this I ſee that what men ordinarily interpret to be animoſities and hoſtilities in nature, among the tribes of animals, are not *animoſities* in the ſame ſenſe as thoſe exerciſed by men; but the application of what would otherwiſe be a *nuiſance*, to a farther purpoſe; and this founded on innumerable and wonderful aptitudes and relations in the nature and bodies of animals, by their Creator.

P. That appears to me the more rational and conſiſtent way of conceiving this matter.

M. I agree with you, and think it looks like

want of candor and fairneſs, to miſconſtrue appearances, which are capable of having a conſiſtent and rational account given of them. Beſides, it ſeems a piece of fool-hardineſs, to meaſure our knowledge with the wiſdom of the Creator.

P. Many learned men have excellently deſcribed the admirable ſtructure of body, the talents and arts of the ſeveral ſpecies of animals, for this effect, who did not ſuppoſe theſe to be helps to cruelty, or inſtruments of malice and mutual hatred. In a word, though there were no carnivorous animal in nature, might not the ſame, or an equal objection be raiſed againſt thoſe that feed on plants? An army of inſects is more terrible than the *wolf*, the *tiger*, or the *lion*; the *ſhark* the *crocodile*, or the *alligator*. Theſe might be commiſſioned to deſtroy every green thing on the face of the earth.——Or, ought there not to have been any inſects in nature? How comes it to paſs then, that there is either *blight*, or *mildew*; *wind*, *rain*, or *thunder*; but according to our preſcription?

M. I ſee there would be no end of ſuch objections, 'till man had overturned all nature, and made himſelf independent.——

LXVI. After this, where go we next; or how doth the ſcale riſe from the *oyſter* and *muſcle*?

P. I am not ſure if it be allowed, that theſe are the loweſt ſort of living creatures; and I only offered them as an inſtance: animal life, like vegetation, begins very low, in more ſpecies than one or two. Yet, I think, the inhabitants of the waters, though exactly fitted to their way of life, are leſs perfect, to our apprehenſion, than the inhabitants of the air or dry land. There are

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divers ſorts of ſhell-fiſh, which are fixt to one place; and the firſt ſpecies that are not thus fixt, as the *ſcallop*, the *periwinkle*, &c. have nearly the ſame ſimple compoſition of parts, and local motion in a low degree. Others tranſport themſelves from place to place, by creeping obliquely on the ground, or by wriggling or flapping on the waters, rather than by regular ſwimming.

M. I have indeed obſerved theſe ſeveral ſorts of motion, in different inſects, at the bottom of the water in ſmall brooks.

P. It is inſtructive, Matho, and wonderful to conſider the beginnings of ſpontaneous motion in thoſe inferior creatures. The mighty author of nature has imitated weakneſs and infirmity (if the expreſſion may be pardoned) to make the tranſitions eaſy, and the modes of motion various. This is remarkable, either in land or water animals, according to the ſtructure of their bodies: but after we are come to the regular ſwimmers, nothing can be more curious than their ſmooth long figure, for piercing through that denſe element. The quick vibration of the tail darts forward the body with a velocity, like that of an arrow in the air.

M. The ſeveral odd ſhapes of fiſhes ſhew us, I think, that there muſt be more modes of motion in *ſwimming* than *flying*.

P. And yet, if you obſerve carefully, you will rarely ſee two different ſpecies of *birds*, or *fowls*, but what have a different ſort of motion, even in their flight.——The ſwifteſt ſwimmers begin to ſhew a tranſition from ſwimming to flying; for one ſort of fiſh, to avoid the purſuit of the dolphin (as it is ſaid) riſes above the waters, uſing its large fins inſtead of wings. The

connexion between *ſwimmers* and *quadrupeds*, is very plain in ſeveral ſpecies; the *water-newt*, the *lizard*, the *ſea-calf*, the *alligator*, and the terrible *crocodile*. The *otter* and *beaver*, though amphibious, are perfect quadrupeds. I cannot pretend to lead you through the ſerpent kind, many of which are likewiſe amphibious, and ſhew another ſort of gradation from water to land animals. In the *cameleon*, and *lizard*, before-mentioned, we ſee the ſerpent and quadruped ſhape blended together. And many ſorts of fowls ſwim on the waters, as well as fly in the air. Fiſhes and fowls agree in this, that both are oviparous; except the *whale*, the largeſt of all animals, which, they ſay, brings forth her young alive: whereas the more perfect land animals are viviparous, and bring forth their young compleatly formed.

M. Might there not be as large animals at land, as in the ſea?

P. The weight of the *whale* is ſupported by the water, a ſoft and yielding element, and therefore by near the ſurface of its whole body: fiſhes being generally of almoſt the ſame ſpecific weight as water. It is otherwiſe with land animals; the *elephant* is ſupported on four feet, a much leſs extent of ſurface in proportion to the weight.

M. I ſhould think the whole weight of the fiſh were ſupported by the under half of its body.

P. If the whole weight were ſupported by half the ſurface, when the half of the body were under water, the fiſh could ſink no farther.

M. It muſt be ſo; when the fiſh is almoſt quite covered, the water preſſes againſt every part of its body.——I could give you an inſtance of the

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connexion between different ſpecies of animals, if I were not afraid it might be trifling.

P. It is not fair, Matho, to be thus on the reſerve; as if we were watching for each other's miſtakes.

M. I have often admired the ſpecies of *mice* and *birds*, united, as it were, in the *bat*, which wants only ſo much of a perfect mouſe, as to ſhew the tranſition to the bird kind.

P. This inſtance is far from trifling. The bat is viviparous, and ſuckles its young, as other mice do. They have no feathers, but are, like mice, covered with hair, and fly by the help of a large pair of membrane-wings, the contrivance of which is very ſingular, being extended on each ſide, between the fore and hind legs.

M. And behind likewiſe; ſo that theſe wings are extended round the whole body, except the head of the animal: and ſurely this is a ſtrange art in contriving flight.

P. There is a ſpecies of *ſquirrels* too, they ſay, which flies; and one ſort of lizards certainly does: and many kinds of inſects, which at firſt creep about under various figures, at length take wing, and mount in the air.

M. You have not yet told me of any creatures that change from one ſpecies to another; pray explain that particular.

P. I ſhall better ſatisfy your curioſity, and give you a ſtronger idea of ſome of thoſe wonderful transformations, by ſhewing you the figures of ſeveral beautiful *butterflies*, and of the *caterpillars*, under the form of which they at firſt creep about upon the leaves of plants, drawn from the life, by the hand of a lady *.

* Madam Maria Sibilla Merian, of Amſterdam.

LXVII. *M.* Here is ſuch a large and beautiful butterfly, as indeed I never ſaw before.

P. It is no wonder; theſe are bred in warmer climates. Look; here is the ſame creature (or the parent of it rather) feeding on that plant, in a different ſhape.

M. Bleſs me! This is a monſtrous loathſome, prickly worm! I ſcarce think it poſſible that ſuch a glorious animal ſhould riſe from that hideous thing.

P. Ah! Matho! I thought you had other notions of poſſibility, when we were ſpeaking of the works of the Almighty.

M. Pardon me, it was my ſurprize. I have ſeen creatures ſomewhat reſembling this before, creeping about on the ground, or on the blades of graſs; but not near ſo large and ugly.

P. You will ſee variety of them by turning over.——

M. Here are many ſorts indeed, as beautiful in the one ſtate, as diſagreeable in the other.—— Here are monſtrous ſpiders too.

P. The deſcription of theſe on the oppoſite page will ſurprize you.——

M. What terrible animal is this?

P. That is a Surinam crocodile, Matho: but you may look over the book at your leiſure another time.

M. You believe all theſe things then.

P. The author of that book was none of your *romancing travellers:* ſhe ſailed to the oppoſite part of the globe, to collect theſe curioſities of nature, many of which ſhe brought home with her. Beſides, the cabinets of the *curious* are full of ſuch creatures preſerved. And though there are not, perhaps, ſuch varieties of ſpecies here,

yet these transformations are as frequent, or rather constant with us, as in America.

M. Pray explain to me the several steps of this wonderful *metamorphosis*.

P. You will find an account of this to better purpose in those authors, who have professedly treated on this subject: but to give you some sort of satisfaction at present, you must know that the butterfly, or parent-insect, lays her eggs in some convenient place, where they may be safe from accident, and her offspring find suitable food when hatched. The animal first produced is a small maggot or worm, which feeds on the leaves of the same plant where it was hatched. The nettle is a great regale for one species of them. This maggot soon grows, by its luxuriant food, to the bigness of a caterpillar, or of those hairy worms you have seen creeping about on the ground. After they have compleated a certain period in this form, they retire to some shelter, and build themselves a *repository* or *tomb*, as if satiated with this sort of existence. Here the animal is to pass into a state of insensibility, or rather dies: for the organized body loses its form, and becomes again a sort of chaos, or is reduced into a mass of confusion. But this proves the *embryo* of a different creature; for from it comes out a shapeless thing, called a *chrysalis* or *aurelia*: and from that deformed production rises a beautiful butterfly, curiously formed, adorned with painted wings, and fit for flight in the air.

M. And in what time are all these changes performed?

P. In a few months of the summer.

M. Pray can you shew me all the *three states* of the same animal, in any of these figures?

P. All

P. All three are repreſented on almoſt every plate. Turn to plate 38. Here is the caterpillar of an enormous ſize: upon that ſtalk below, is the *lumpiſh aurelia*, into which it is transformed: and this is the butterfly, or *phalæna*, which riſes from the *aurelia*. It remained in the *aurelia*, or *inſenſible ſtate*, from the 23d of June to the 20th of Auguſt.

M. What are theſe?

P. That is the *proboſcis* of the animal, three or four inches long, divided into two. It unites both parts, and thereby forms a *tube* or *pipe*, wherewith it ſucks the honey from the bottom of the flowers.

M. What are your thoughts concerning this metamorphoſis?

P. It appears to me to be a ſucceſſive evolution of bodies, ſuch as perhaps the Greeks would have called a *metaſomatôſis:* but whether, as there are three different bodies, one included in another, there be three different living creatures, or only two, or but one, I cannot determine.

M. This is the moſt wonderful particular, I have yet heard of.

P. It is indeed a miracle made conſtant, or appointed to be a ſettled courſe of nature (as every proceſs of generation is, if rightly conſidered:) for the ſpecies of theſe creatures, which paſs through changes analogous to this, are very numerous. The *ſilk-worm* is one of them; and the place ſhe builds for her transformation is all of that ſoft and fine material. The common white butterfly comes by a like proceſs, from the green caterpillar you have ſeen feeding on cabbage-leaves. And all thoſe ſorts of *phalænæ* or *moths*, which fly about in the evening, or by candle-

light,

light, are thus produced by a double or triple generation.

M. I am glad there are ſo many ſpecies of them; I ſhall the more eaſily obſerve thoſe ſurprizing changes of figure in one or other of theſe ſorts.

P. See here on this plate, drawn by the ingenious Mr. Bradley, eggs of the ſilk-worm:——That is the *caterpillar* or *nympha*, which is hatched from theſe eggs:——This is the *cone* or *bag of ſilk*, which the caterpillar ſpins for her own monument:——This lumpiſh thing is the *chryſalis*, which is excluded from the ruins of the caterpillar's body:——And this is the butterfly which proceeds from that chryſalis, and again lays the eggs, to renew the ſame circle of generation.

M. One cannot enough admire this complex proceſs.

P. Below you ſee the caterpillar that feeds upon the nettle, with the chryſalis and butterfly ariſing from it.

M. It is this ſort of caterpillars, but ſomewhat blacker and larger, I have ſeen creeping about on the ground. But what mean theſe horns of the butterfly?

P. Theſe are called its *antennæ* or *feelers*, of which there is a great variety, according to the ſeveral ſpecies of thoſe animals. They have likewiſe *tubes* or *ſuckers*, as you ſaw above, for thruſting down into the ſockets of flowers, which at other times the inſect coils up very artificially under its mouth, ſo that they do not appear.

LXVIII. *M.* I have obſerved this ſort of butterfly to hang or ſtick, as if it were dead, in ſome *by-corner* of a room, during the whole winter; and

to begin to fly about again when the ſeaſon became warmer.

P. There are many creatures, Matho, which thus paſs the winter in a ſtate of numbneſs or ſleep, and revive again in the ſpring. Had the place been warm enough, you would have ſeen the butterfly flutter about the glaſs of the window in the day-time, all winter.

M. I remember, indeed, to have ſeen, after a long and ſevere froſt, the little flies begin to move and jump about, even upon the ſnow itſelf, before it was quite diſſolved. Pray how can theſe little animals endure ſuch intenſe cold, for ſo long a time, without periſhing? They have neither coverings of hair nor wool; nor ſhelter to fence them from the piercing winds, nipping froſts, or rain. Larger animals would be ſtarved to death in one ſingle night of ſuch lodging.

P. All we can do here is to admire, without being able to underſtand, how theſe creatures are thus preſerved.

M. How can they live without food all the time?

P. Naturaliſts obſerve, that, while in ſuch a ſtate, they ſuffer no waſte or decay of parts; and therefore require no food.

M. Should you or I ſuffer no decay of parts, if we ſlept conſtantly for three or four months together?

P. The caſe is different: we ſhould ſtill breathe, and perſpire (as they call it) which would occaſion a conſtant waſte of our bodies.

M. Do not theſe animals live, while in a dormant ſtate?

P. I confeſs, Matho, I do not underſtand theſe things, and therefore cannot anſwer your queſtions.——

M. You

M. You said the *insects* returned only with the verdure and herbage of the earth, which was to afford them food.

P. None of those winged insects, which survive the winter, feed on plants or leaves: these are their food only in their *nymphæ*, or *vermicular state*, the summer before. They change their diet with their shape; nor have the winged creatures any apparatus, I believe, for mastication of vegetables.

M. Are there no larger animals than *insects*, that pass the winter in a state of numbness and sleep?

P. The *bats* you mentioned are another species of those *sleepers*.

M. These I might have thought on: I have known their retreat in a hole of a wall, where great numbers of them lay the whole winter, without stirring.

P. The *swallows* likewise retire in October, and pass the winter in a motionless, and seemingly lifeless state, under the hollow banks of rivers; so that not one of them is to be seen in all the country, after a certain day.

M. Might not one try to keep them in cages all the winter?

P. It is a creature that cannot be tamed. Though the *lion* and the *elephant* may be made familiar with mankind; yet such small creatures as the *mouse* and the *swallow* are quite untractable; as Pliny informs us.

M. I am willing to believe it; for the less creatures are, they seem the more imperfect, and must therefore be the more intractable. No art, I believe, could tame a *beetle* or a *spider*.

P. Some animals are of a savage nature: but the chief reason seems to be, that we do not

know

know their diet. The *ſwallow* lives on inſects, and is the only creature that feeds flying. On this account, Providence hath kindly ordered its retreat during the winter: and on the ſame account, all ſorts of *ſpiders* paſs that ſeaſon in a dormant ſtate: the *ſerpent-race* alſo, which feed on *frogs*, *toads*, and ſuch like animals, ſuffer an intermiſſion of ſenſe all that time.——

Qualis ubi in lucem coluber, mala gramina paſtus,
Frigida ſub terra tumidum quem bruma tegebat.

M. You deal much in the poets: but this does not ſatisfy me how the bodies of theſe animals, eſpecially the *ſwallows*, could lie ſo long in ſuch circumſtances, without being diſſolved, or corrupted.

P. I have as little to ſay to this inſtance, as to that of the *inſects*. If the blood of the creature circulates all the while, that will prevent corruption or diſſolution.

M. The difficulty ſtill remains. Why does not lying ſo long in ſuch wet and terrible circumſtances, directly ſtop the circulation, and kill the creature?

P. As theſe ſeveral ſpecies of animals, Matho, are ſingular inſtances of the Creator's care, and of the various methods of his providence; ſo his power is manifeſted in them, above the common courſe of nature: and it ſhews us, that when he pleaſes, the continuation of life does not depend on food. It is certainly matter of admiration, that an animal ſhould live only two or three months of twelve, and paſs all the reſt of the year in a ſtate of inſenſibility: and yet, by all the accounts I have ever heard, this is true of the

cuckow;

cuckow; which, having early finiſhed the buſineſs for which it appears, retires in the month of June, and is not ſeen again (at leaſt with us) till the April following. Nor is it reckoned among thoſe birds which change their climate.

M. This is, indeed, a notable inſtance of variety.——But with reſpect to the life of animals; pray tell me how it happens, that if a part be cut off from ſome creatures, that part ſeems to live for a conſiderable time by itſelf, or at leaſt moves? I have ſeen the tail of an *eel*, when ſeparated by a ſtroke from the body, move and twiſt itſelf for a great while.

P. I am as ignorant of this as you are. *Anatomiſts* have obſerved, that ſome *inſects* have ſeveral lungs, and therewith ſeveral hearts. This might account for the boys cruel diverſion, of ſeeing a *fly* whirl round, after they have taken off its head: but it is not applicable to *ſerpents*, *eels*, and ſeveral ſorts of *fiſhes*. The very *leg* of an inſect will move for a ſmall ſpace, when torn from the body, where there can be neither heart nor lungs.——With reſpect to all theſe things, I can only ſay again, that our very ignorance is not without ſatisfaction, when we conſider that it is neceſſary concerning objects, where infinite knowledge and power have been exerciſed.

M. It muſt be ſo indeed. But,

LXIX. As ſome birds retire, to paſs the cold ſeaſon in a ſtate of inſenſibility, you ſeem to ſay that others remove to diſtant countries then.

P. It is certain many ſorts of birds ſhift their climate according to the ſeaſon of the year. The *woodcock* comes to us in October, and the *quails* in April; and after ſome ſtay, both ſorts retire

again.

again. Theſe are called *birds of paſſage*. One ſort of geeſe comes yearly to breed on ſome particular rocks only on our coaſt, and are ſeen no more the whole year round. The *ſtork* and the *crane* have been memorable in all ages, for their annual peregrinations, though they do not viſit us. Theſe birds of paſſage are ſeen after their return, and are obſerved to aſſemble in great flocks in order to go away; but no body ever ſaw them coming or going: whence it has been ſuppoſed that they remove and return only in the night-time. But what ſeems wonderful in this caſe is, that they ſteer their courſe, as well over ſea, as dry land. When the woodcocks come to our iſland, they are under a neceſſity of croſſing the ſea. Quails have been often ſeen in their paſſage at great diſtances from land. There are other ſorts of land-fowl alſo, which mariners are ſurpriſed to ſee flying above them, a great way from any coaſt. Nor is it leſs certain that ſome ſpecies of fiſhes paſs and repaſs between diſtant parts of the ocean annually at ſtated ſeaſons. The *ſalmon* in our rivers ſwim up as far as the water can carry them, for the ſake of repoſiting their ſpawn in ſuch a depth, where the influence of the ſun may reach it; which having performed with ſurprizing exactneſs, they return without farther concern, leaving the future fry to be inſtructed in the arts of life, in the watery element, by another hand.

M. The meaning of that expreſſion I do not conceive: but though every particular you have told me be wonderful, yet it is moſt ſurprizing that birds bred at land ſhould fly quite out of ſight of it, and venture themſelves above the ocean, where they can have neither food nor reſt! How-

know

know they on what point of the compaſs to fly; or that there is at all any land beyond ſuch a tract of ocean? Did they ever conſult the map for the ſituation of countries? Or what do they when night overtakes them?

P. Do you think, Matho, if you were put between a pair of wings, that you could guide yourſelf through the air, and in the dark too, to a diſtant country you had never ſeen before?

M. The greateſt philoſopher could not do it: it is a thing above the reach of human knowledge.

P. You own then they are guided by ſome more perfect principle than human reaſon?

M. I remember what you ſaid, but will own nothing, till you tell me the principle itſelf.

P. Have you ever conſidered a *honey-comb*, or a *ſpider's web?*

M. Often, and with admiration.

P. Who teaches theſe little ſhapeleſs *inſects* to work ſo artfully with ſuch tools, and in ſuch materials?

M. I cannot tell; but it is ſtrange that the *ſpider* ſhould ſpin a ſubſtance, which is liquid in its own body, into ſo fine, and withal ſo ſtrong a wire.

P. The wire which the *ſilk-worm* draws out of the juice of her body is no leſs remarkable both for ſtrength and fineneſs. A hundred yards of it do not weigh a grain.——

M. But this is from the purpoſe of my queſtion.

P. Not ſo far as you imagine. Tell me if a *young lady* were transformed into a *ſilk-worm*, or a *ſpider*, as the poets ſay Arachne was; do you think that her being ſhrunk up into that diminutive figure, would teach her either of theſe notable arts?

M. That

M. That would be to ſuppoſe that the *mere figure* taught theſe inſects their dexterity. Their figure can teach them nothing, though it muſt be adapted to their art, as was obſerved before. A *loom* could not teach a man the art of weaving, nor any other *inſtrument* the art in which it is employed: but one, who underſtood or had invented the art of weaving, might contrive a *loom* to put the invention in practice.

P. You argue unexceptionably well, Matho.

LXX. We admire the wire drawn by a worm or ſpider: what do you think of the *hair* and *wool* of animals?

M. I can ſee no ſimilitude between theſe and the former.

P. The *hair* and *wool* of animals are formed out of a liquid ſubſtance; they are fine and ſtrong too.

M. But they grow, inſtead of being drawn, or ſpun.

P. Does *growing* then appear ſo ſlight a thing? Theſe ſeem ſo much the more wonderful, as there is no living creature to aſſiſt or produce the effect? There is nothing here but unactive matter.

M. I am afraid I ſhall be obliged to come over to your ſide.

P. *Hair* and *wool* are more than wires: the *curious* have obſerved that the ſlendereſt hair is a hollow tube, with a pith or internal ſubſtance in it.——Obſerve this figure: here is the ſingle hair of a mouſe, as obſerved through a microſcope by the excellent Mr. Derham.

M. Surprizing! Is this variety of work within the compaſs of a ſmall hair? How amazing is this minuteneſs of art!

P. The

P. The hairs of larger animals are each a bundle, or congeries, of ſuch pipes or tubes, which in ſome caſes can be ſeparated: ſo that finery, deſign, and a complication of contrivance, reigns every where, in the very excrementitious parts of the bodies of animals.

M. Well, I own that the ſingle hair of a mouſe is by much a more fine and artificial thing than the ſpider's or ſilk-worm's thread. I did not reflect on the myſtery of vegetation; the particular direction of every atom! But even theſe threads or wires are wonderful, if we conſider them as the manufacture of a poor little inſect.

P. Yes, if we might conſider them in that view: but you have allowed already, if one of the human ſpecies (ſome great philoſopher, for inſtance) were contracted into this diminutive unpromiſing ſhape of a caterpillar or ſpider; that the being transformed into ſuch a figure, could not teach him that art.

M. It could not, if he did not underſtand the method and ſecrets of that art at preſent, with the help of all his reaſon. If mere ſhape or figure can teach a creature nothing, change of ſhape or figure could not teach the philoſopher more.

P. Do you think that the caterpillar knows what it is doing, and to what purpoſe or end it works, while it manufactures the ſilk?

M. Why ſhould it not?

P. Does it know that this cone of ſilk is to be a *repoſitory*, where the remains of its carcaſs are to be ripened into a *ſhapeleſs grub*, out of which a nimble-winged creature is to riſe?

M. Pardon me; it cannot know this wonderful proceſs of generation, nor what is to ſpring from the decays of its own body. This exceeds

ceeds the knowledge of the moſt perfect animal.

P. It cannot then have any notion of what it is doing, while it is building its own monument?

M. It works thus, I ſuppoſe, without knowledge, for the ſatisfying of ſome appetite.

P. You owned before, at our laſt meeting, that power, not directed by knowledge, is but *blind chance*, or *temerity*, which can produce no conſiſtent or regular effect. But here in this operation, the inſect works on a long, pre-contrived, and really myſterious deſign, without knowing what it does; and yet it does all in the moſt regular manner. For here you are to remember, that every individual of the ſpecies works exactly in the ſame regular form, and that for the firſt time: a creature can die but once.

M. I know not what to ſay then, or how the animal is directed. I am ſatisfied it cannot know the *metamorphoſes* that are to ſucceed: and how it ſhould act ſo conſiſtently to this end, and not know of it, I cannot find out.

P. Does the *ſpider*, think you, know beforehand the nature of the liquor in her body; and that it will become a tenacious wire in the open air, though ſpun ſo fine?

M. I am at a loſs what to anſwer to theſe queſtions. I am ſure we could not know the nature of this liquor, but from the effect already performed: and I do not think the *inſect* knows the nature of the liquor at all, but falls directly to ſpinning, I cannot tell from what principle.——

P. The diligent enquirers into nature have obſerved, that many ſorts of flying inſects have a *piercer* or *terebra*, with which they wound the buds or leaves of trees, plants, fruits; and inſert in the wound their eggs, with a liquor or kind of

venom,

venom, which perverts the regular vegetation of the plant, producing an excreſcence, where the egg is hatched, and the maggot fed; or where perhaps the animal, according to its kind, is preſerved the whole enſuing winter.

M. This is agreeable to what you told me before, of plants ſerving for food, and a place of nativity, to the firſt period of *inſect-exiſtence.*

P. Now can theſe little creatures know, that the liquor they ſhed is of ſuch a hurtful quality to the plant, as to diſtemper, or raiſe a ſwelling, or *button* upon it, which may afford lodging to their young, when hatched? Or that the matter of this excreſcence will be proper food for them, till the ſeaſon returns, and the verdure of the earth is renewed? For, as was ſaid before, the *mother-inſect* never taſted of this food herſelf, but purſues quite a different ſort of diet.

M. That would be to allow them a readier inſight into the nature of vegetation, and a more extenſive knowledge into the congruity between one thing and another, than man has with all his experience, or could have, unleſs he were thus taught by what theſe little animals practiſe. And I think it is not to be imagined that a creature, which lives but for one ſeaſon, ſhould know any thing of the variety of return of ſeaſons.

P. You are in the right; theſe creatures are produced themſelves, a few weeks only of the ſummer before they do all this. And there is one ſpecies of theſe little inſects, which lives only but a few hours after it becomes a winged animal; and yet it performs all the offices relating to its poſterity, as if it had acquired the experience of many years.

M. One cannot enough admire thoſe miracles of nature.

P. Let us again take a view of the little *fry* in the waters, which, immediately on being excluded the ſpawn, are left to ſhift for themſelves in the midſt of a rolling element, ſurrounded with innumerable enemies; and yet, without tutor or guide, they inſtantly become perfect maſters of all the arts of life, as I obſerved.——

M. Pray, without giving me more examples, or aſking me more queſtions, ſhew me how theſe little inſects act thus regularly, without knowing what they do? Or by what *principle* they are thus guided to purſue ſuch diſtant proſpects? For I grant you now as much as you pleaſe, that this principle is inconceivably ſuperior to the reaſon of mankind.

P. You know I am not raſh in anſwering ſuch queſtions.

M. Well! Thus it is to be nurſed and tutored in what one does not know by one's ſelf.

P. More examples (as you ſay) are needleſs; for it is by thoſe untaught arts, and unknown to theſe weak creatures themſelves, that all the inferior ſpecies, without any exception, are continued as ſecurely, as the race of ſtronger animals, or as man himſelf is.

LXXI. *M.* I am ready to believe it; ſuch weakneſs muſt be conducted by ſome wonderful art: but in the interim, till I can know more of this affair, pray inform me if all ſorts of inſects go through theſe changes, from a firſt, to a ſecond and third ſtate of exiſtence?

P. All do not; there are many *reptile-inſects* which never take wing; but all winged inſects

(ſo far as I know) paſs through one or more changes; if perhaps we except the *ant*, for ſome of them likewiſe get wings. The different transformations of the *gnat* are not leſs wonderful than thoſe of the moths and butterflies; and in one reſpect more wonderful, as their firſt ſtage of exiſtence is in the waters. So that this inſect alone ſhews us the tranſition from creatures that live in the waters, to thoſe that ſubſiſt on dry ground; and again, from thoſe that ſwim or creep, to thoſe that fly in the air. And indeed the ſpecies of thoſe winged inſects, which paſs their vermicular ſtate in the waters, are very numerous. The *ephemeron*, which, as was mentioned juſt now, lives but a few hours in its laſt ſtate, is one of them. Some of theſe form to themſelves, by the help of a glewy ſubſtance, which deſcends to the bottom of the water with the eggs out of which they are hatched, little rough *caſes* or *tubes* of ſand, ſmall gravel, or the like; which they draw after them when they ſearch for food, and into which they retire in time of danger.

M. I now remember; it is long ſince I have obſerved theſe artificial caſes, in ſprings and ſmall brooks; and was ſurpriſed to ſee a compoſition of ſand, ſmall ſtones, and other materials, as I imagined, move like a living creature.

P. The *ſcarab*, or *beetle-kind*, of which there are ſeveral ſpecies, undergo transformations not unlike thoſe taken notice of before; as doth the beautiful inſect called the *lady-cow*, paſſing through a *nympha*, *aurelia*, and *mature* ſtate; and it has, like the beetle, what they call *elytra*, or *caſe-wings*.

M. From what you ſay then, I underſtand theſe *elytra*, or *caſe-wings*; for we have often been

diverted with ſeeing the beetle prepare for flight; and the ſight is really entertaining. He firſt raiſes one of his black ſcales, as if he were opening a door in his ſide, and extends a folded wing, which he expands at leiſure. Then he opens the caſe on his other ſide, and having put the other wing in order, takes flight. He makes an odd ſort of a figure while on wing, with his two ſcales ſtanding erect, as if he carried ſomething on his back: nor is it leſs amuſing to ſee him alight; for as he does not fly far, we have followed him. He takes ſome time to fold up his wings again, which he does by degrees, firſt on the one ſide, and then on the other; and having brought them within their *caſes*, he claps down the lids on them.

P. It is a ſingular creature indeed, as if it were a compoſition of a tortoiſe and a winged fowl.

M. We have teaſed him to make him fly; but being haraſſed, he rather truſts to his *coat of mail*, than to his unwieldy flight.

P. It is ſtill more wonderful, that ſuch a creature as the *ſpider* ſhould fly, without the help of any wings at all.

M. I can have no notion of their flying; but I have obſerved a ſpider to jump, or dart itſelf to a conſiderable diſtance, from one part of the wall to another, and ſometimes perpendicularly upward.

P. Though I never ſaw them fly, I am ſatisfied of the fact, as perſons of the greateſt veracity have given the accounts of it, and vouched it from their own obſervation.

M. Then, I think, I underſtand how they extend their webs between the tops of buſhes, and very often a-croſs ſmall rivulets: they muſt either fly, or dart themſelves over with their threads.

P. It muſt be in ſome ſuch manner, for they are not *ſwimmers*; and a great part of their game is over ſmall brooks.

M. But pray what are we to think of thoſe innumerable threads, which we often ſee ſtretched upon the tops of the graſs, all parallel-wiſe, ſo that whole fields are ſometimes covered with them, eſpecially after the harveſt-months? If you look at the ground between you and the ſun, when riſing or ſetting, you will ſee the threads ſtretched along, ſhining like virginal-ſtrings.

P. Theſe, they ſay, are the work of *field-ſpiders*, or *wanderers*, as they are called; but whether ſuch ſpiders leave their threads looſe at one end, to be diſpoſed in a parallel direction by the wind; or if they leave them quite looſe and floating in the air, I can give you no information.——

M. I have a ſuſpicion, that other animals undergo conſiderable changes of figure, between their firſt and laſt ſtate, as well as *inſects*.

P. All animals whatever, I believe, are of a different form, when yet imperfect, from what they are afterwards: but on what ground do you entertain this ſuſpicion?

M. I have ſeen in ditches, ponds, and ſtanding waters, *frogs*, under three or four different ſhapes. I have caught them in my hands little *tad-poles*, with ſmooth round heads, and finny tails, by the quick vibration of which they could ſwim pretty nimbly, conſidering the club-figure of their heads. I have ſeen them with their head and belly larger, and two feet ſprouted out behind; but they did not then ſwim ſo cleverly. By viſiting them every day, I have caught them with two fore-feet, not fully branched from the body, and the tail ſtill pretty long: and I have

ſeen them with the tail not quite fallen away, after they have left the water, and been leaping about on the graſs. In a little time after, they had no veſtige of their tad-pole ſhape. Here ſeems to be an evolution of members, at leaſt: for the animal in its firſt ſtate appeared as different from itſelf in the laſt, as a fiſh is from a *quadruped.*

P. It is not difficult to obſerve thus far, Matho; but the animal had undergone conſiderable changes from its ſeminal ſtate, before you took notice of it. And if the obſervation were as eaſy to be made on other creatures, probably there is full as great a difference between their *firſt imperfect* and laſt *ſpecific figure.* All the larger creatures ſeem at firſt to be *ſwimmers*, as they are ſurrounded with a liquor.

M. Perhaps the firſt thing diſcoverable here, is an animal in miniature, as it was in vegetables, where the future plant is ſo diſcovered.

P. It is ſo indeed; the firſt thing diſcernible, is a ſmall, ſpontaneous, moving creature, or animalcule; but (to uſe your expreſſion) as far different from the future animal, as a fiſh is from a quadruped. As to the geneſis, or firſt formation of this *animalcule*, we are entirely ſtrangers to it. Nature (to ſpeak in the common way) has carried the firſt beginnings of animal, as well as vegetable life, quite out of the reach of our faculties.

M. Some things occur from what you ſay, which ſurprize me. If the *elephant*, the *horſe*, the *ſtag*, and the *bull*, were firſt in the form of the *ſwimming fry*, they muſt have undergone great changes indeed! When I compare this with what I obſerved before, concerning the formation of

inſects, by a double or triple proceſs, it is exceedingly more wonderful than what we admired before, in the propagation of plants by ſeeds. And I differ ſtill more from *thoſe* who aſcribe the regular continuation of the ſpecies, either from plants or animals, to certain little, pre-exiſting, or pre-contrived ſeminal atoms. Every thing in theſe *ſucceſſive evolutions* requires the immediate operation of the Creator's hand. If thoſe things were left to the care of dead atoms, and if any thing at all could be produced, what ſhould hinder *one* grain from riſing where *another* was ſown? or the *fox* or *ſerpent* to be formed inſtead of the *lamb* or the *dove?*——O! the amaſing univerſality of thoſe miracles, which are conſtantly wrought through the whole creation, that we may have a regular courſe of nature!——How ſhall I deſcribe the burthen of thought which I feel in my mind, when I would purſue the power of the *Creator*, every where at once forming the living part of the creation!——

P. I ſhould almoſt envy your pleaſure, Matho, if I did not participate of it: but no words can expreſs ſuch a ſcene of power, where admiration itſelf muſt fail.——

M. Shall we conclude then from what we have obſerved, that fiſhes ſuffer the leaſt change of ſhape, before they come to their adult ſize; as their ſtate of perfection and imperfection are not ſo far aſunder as in other animals? That all bodies are formed out of matter in a liquid form? And that fiſhes are the eldeſt children of the creation?

P. There is a degree of probability in all this: but it is rather time to conclude our preſent conference. If we grow more minute, we ſhall grow

more trifling; becauſe we cannot talk on ſuch ſubjects, beyond a certain point, with intelligence.

M. I find I cannot recall all the queſtions I had a mind to aſk at this time; only let me obſerve, that

LXXII. One thing you ſaid a little before, concerning inſects piercing the leaves and gems of plants, clears up a particular I did not before underſtand, and relieves me from a prejudice. I have often been ſurprized at thoſe little berries upon the back of the oak leaves, ſome red, and ſome a greeniſh white, but did not underſtand their original: now I ſuppoſe they are the excreſcences raiſed by ſome inſect wounding the plant, and leaving its eggs there.

P. Theſe are raiſed by a black ſort of fly, of the ſhape of a large *ant*, which is one of what they call the *ichneumon* kind. If you had viſited thoſe berries through the ſucceeding winter (for they ſtick on the leaves during that whole ſeaſon) you would have ſeen the ſeveral advances of the formation of the inſect. It becomes a clear whitiſh maggot, not unpleaſant to look at; which about the month of March eats its way out of confinement: and then you may perceive thoſe berries, each with a hole exactly round in it, through which the inſect creeps out. You will frequently ſee alſo ſuch ſwellings on the back of the willow leaf, but broader.

M. I know now likewiſe what to think of thoſe worms I have found in *peaſe*, *raſberries*, and even *nuts*, which before I was at a loſs how to account for. I have often heard that maggots breed ſpontaneouſly in fleſh, or any thing that begins to putrify; and was not ſure but theſe *might have* been bred the ſame way.

P. It

P. It is now diſcovered, Matho, by the moſt *accurate enquirers*, that there is no ſuch thing in nature as this ſpontaneous or equivocal generation you mention. Every inſect, how minute and contemptible ſoever it may appear to us, is produced, by a regular proceſs, from others of the ſame ſpecies. If no plant, the moſt imperfect, riſes, unleſs from a ſeed of the ſame kind, it is not to be imagined that a regular courſe of nature ſhould not be as conſtantly obſerved in the propagation of animals. It is true, after we have diſcovered the nature of matter to be what it is, we muſt be certain that no plant, or animal, could be produced without the immediate power of the Creator, whether raiſed from a ſeed or not: but leſt we ſhould be ſtumbled by our own inattention, the Deity hath taken care (if I may ſo ſay) that the firſt *ſtamina* of every production ſhould have paſſed through infinite art, before it come within our ken. Hence we cannot but revere the *divine wiſdom* and *goodneſs*, in putting it thus out of our power to doubt.——Fleſh of any ſort, if it be carefully covered up, ſo that no inſect can get at it to lay its eggs there, will never verminate or breed living creatures, as hath often been tried. There are indeed ſome dubious appearances, that ſeem at firſt to favour irregular generation: but when circumſtances are cloſely conſidered, the difficulty diſappears.

M. What appearances are there?

P. As the *leſſer inſects* are extremely productive of their kind, they are conſtantly depoſiting their eggs in all places where they may be hatched and fed; on *herbs*, *fiſh*, *fleſh*, *liquors*, and the *bodies* of other animals. This occaſions abundance of equivocal appearances. Hence it comes to paſs,

that ſome ſorts of inſects are hatched on the bodies of living animals as vermin; the eggs being depoſited on theſe by the *parent-inſect*. There are few larger animals that are not thus infeſted with a particular ſort of *inſect-vermin*, eſpecially when lean, and in bad caſe, juſt as it was in plants. And the bodies of dead animals afford a convenient *nidus* for the eggs of others. The caterpillar laid up to be turned into the *chryſalis* of its kind, having been punctured by other inſects, has bred a neſt of maggots of a different ſpecies, inſtead of advancing in the regular proceſs: and I have ſeen a living inſect, on being taken out of the water, void another of a tribe not at all related to it.

M. Theſe are equivocal appearances indeed, enough to ſtumble one, who is not aware of this manner of conveyance.

P. As water itſelf, graſs, herbs, fruits, and even liquors, abound with the eggs or ſpawn of creatures of different forms; it is no wonder that worms of various kinds ſhould be bred in the inteſtines and other parts of larger animals; having been conveyed thither with their food and drink.

M. It is not: the wonder rather is, I think, that other larger animals are not eaten up with an internal vermin, thus conveyed into their bodies. This makes me reflect on what you ſaid before, *That an army of inſects might be more terrible than the lion or the tiger*, and that more ways than one. I now plainly ſee, that the leaſt and weakeſt creatures in nature might prove too ſtrong for the greateſt, and devour them ſafely, having thus got into their bowels.

P. Nor is it at all wonderful, that creatures hatched in ſuch unnatural circumſtances ſhould

degenerate

degenerate and vary from their ſpecific ſize and figure. Nature (to ſpeak ſtill in the common phraſe) deſigns every thing regular in its kind: but accidents may prevent nature; and therefore *accidents only occaſion what is preternatural and monſtrous.*

M. Make this a little plainer.

P. If the young of any ſpecies whatever ſhould be brought forth, with any part of the body double or ſuperfluous, that is a token that nature deſigned two; but ſome external cauſe or violence diſturbed the natural formation, and blended both into one. And it is equally conceivable, that by ſuch violent diſturbance a limb may be diſplaced or wanting: for the *fœtus* being then tender and ductile, the vegetation or growth proceeds in different manners.

M. I underſtand: it is as eaſy to conceive this, as that *children* ſhould grow deformed, or irregularly ſhaped, by a fall, or ſome accident, even after they are born. A tree, or the fruit of it, might be made to grow in various ſhapes, I ſuppoſe; if it were gently trained from the natural bent, when flexible and tender.

P. You are in the right. Now if a child ſhould be born without legs, or without arms (inſtances of which have been) taking the external violence or accident into the reckoning; it is juſt as natural, as that a man ſhould have a *cicatrice* upon his body after a wound or ſore; or as that he ſhould have but one leg after the other hath been ſhot away.

M. What you ſay of having the parts of the body double, brings to my mind the famous ſtory of the *twins* in the reign of James the Fourth of Scotland, which thus appears not impoſſible at leaſt.

P. Theſe brothers having lived twenty-eight years, and having been taught muſic, &c. makes it hard to ſuppoſe the relation fabulous.

M. Hence, I think, we may account why more of the human ſpecies are deformed, or monſtrous, than of any other ſpecies: for being weaker both before and after birth, and depending longer on the care of others, they muſt be more liable to accidents. From theſe conſiderations I can eaſily believe, that monſtrous productions happen from ſome external cauſe or violence.

LXXIII. *P.* This then prevents, in a great meaſure, what I was going to ſay; and will help you to account for many ſtrange appearances of animals, bred in ſeveral parts of the bodies of other animals, without allowing either equivocal productions in nature, or a want of ſuperintendance in the formation of the bodies of animals. Worms of an unuſual length and ſhape have been bred in the inteſtines of ſome perſons; which, in other circumſtances, muſt have been of the ſpecific ſize and figure. Inſtances hereof you will meet with in authors of unqueſtionable veracity: but it would indeed be trifling, to be more particular here in the application.

M. This way of accounting for what may appear *monſtrous* is both natural and intelligible.

P. Conſider, that either the vegetation of animal bodies muſt go on, notwithſtanding *unuſual poſitions*, or the diſturbances the *ſemina* may meet with; or, that the *Author of nature* muſt ſuſpend *the courſe of nature*, whenever ſuch accident happens, which muſt make the courſe of nature quite precarious. In ſhort, the *exception* here is in conſequence of the *general rule*.

M. I see very well, that the state of the human body itself would be altogether uncertain, if, as often as any external violence happened, either before or after birth, the growth and vegetation of it were at an end. Every *hurt* or *accident* must then prove mortal. It is as if we supposed a tree would not grow, but according to one precise shape.

P. These are liable to so many external violences, that we find a distorted shape in them, is not reckoned at all extraordinary: and if we consider preternatural formations of any animal body in this view, they are so far from being arguments against a providence, that (as has been said) taking in the supervening accident into the account, they are produced in consequence of the settled course of nature.——It is, perhaps, scarce worth while to take notice, that the *similitudes* between parents and children might be alledged as an objection to some things we have said: but the dissimilitudes prove as much, at least, the one way, as the similitudes do the other. Both are casually superinduced, long after the *seminal stamina* are compleated, and by quite a different cause from what such objection would suppose. If it were not so, all the individuals of every species would be exactly alike.——And now, I hope, we have done for this time, Matho.

M. I am just ready to leave you, Philon; and after this conversation, wherever I am, I shall always be less alone, than otherwise I should have been.

P. All we have said can only serve to set your thoughts at work, and put you upon making your own observations.

M. I find already, that is no small article in

any

any part of rational life: and on this account I was reſolved to aſk your advice, if it might not be to the purpoſe to get a ſet of good *microſcopes*, and to learn to manage them myſelf.

P. It would not, indeed, be improper: your eyes are good, and to make obſervations, though equally inſtructive with the moſt ſerious ſtudy, is as pleaſant diverſion as any young perſon can deſire: for the microſcope, Matho, is really like an *inchantment*; it opens new proſpects in the moſt ordinary and neglected objects, and often diſcovers ſurpriſing ſights, where we thought there was nothing but what we knew. In vinegar, where one expects to ſee nothing beſides the liquor itſelf; or in water, wherein ginger, pepper, or ſome ſuch hot ſpice hath been ſteeped; the microſcope diſcovers inconceivably ſmall *animalcula*, of different ſorts, ſwimming up and down: whence it is reaſonably inferred, that the air itſelf is, in the ſummer months, full of inviſible living creatures.

M. How is it known that theſe animalcula were not originally in the water?

P. If the ſame water be kept covered from communication with the open air, no ſuch creature can be ſeen in it. And ſuch diminutive *things* could neither creep, nor move upon any dry or ſolid body: ſo that they could have no motion, but in the air, or in ſome liquor.

M. That conſideration ſeems to put the point out of doubt. But what ſhould bring them to water thus prepared?

P. The ſtrong *odour* invites them to repoſite their eggs in ſuch liquor.

M. This diſtreſſes the imagination, to conceive an organized body, with difference of parts fit for life and motion, wrought up in ſuch nar-

row

row bounds. You had reaſon to ſay that the beginnings of animal life are carried far beyond the reach of our faculties. And then how ſmall muſt the *particles of odour* be, which they can ſmell! Whether we go upward or downward, in the works of nature, all is amazing! We may know a little about the middle, but cannot come near either of the extremes.

THE

Sixth CONFERENCE.

Conſequences from the ſubject of the laſt conference. That it doth not belong to any power to make matter a ſelf-moving ſubſtance: ſuch ſuppoſitions proceed from our ignorance, in joining together, in our own imagination, inconſiſtent effects. The folly of appealing to omnipotence in ſuch caſes, or where other proofs may be had, which are more within our reach. Hence all the motions in the univerſe are owing immediately to an immaterial cauſe. Of the ſeveral motions in the animal body, on each of which life depends. The various motions produced by the Deity in vegetable and animal bodies may be called mechanical, *becauſe of their conſtancy and regularity, and the infinite fineneſs of the effect. Of ſpontaneous motion. The greateſt part of ſpontaneous motion mechanical in this ſenſe. Two diſtinct powers, or two different* motives, *concur to produce ſpontaneous motion. Of the human and brute ſoul. The moſt perfect brutes irrational: nothing more confirms this opinion than the objections that are brought againſt it. Of* reaſon *and* inſtinct. *The wonderful nature of inſtinct. This the connexion between the vegetating and animated parts of the ſcale of beings. The miſery it muſt be to mankind, if brutes reaſoned. The different ſtructure of body does not make the human ſoul rational. Eternal truths diſcover to*

us, immediately and by themselves, an eternal intellect, &c.

LXXIV. *M.* I Am afraid you will think me a little inconstant, Philon; since sometimes I visit you in a few days, and sometimes not till after several weeks.

P. One who knows the use of time so very well, Matho, will always be profitably employed, and in one place as much as another: but I hope you have been well all the while?

M. Well, I thank heaven; and so much the better, as our last conference has afforded me great pleasure since I left you.

P. In what, pray?

M. When I walk abroad, I can hardly see any thing, *bird*, *beast*, or *vegetable*, but what offers me some subject to exercise my thoughts upon. You have directed my *unmeaning curiosity* to a consistent end; and I hope I am less in danger, than formerly, of falling into that irksome state of growing weary of myself.

P. The mind of man is an *active*, *restless being*, Matho; and it is of no small consequence in rational life (as you observed) to furnish it with proper matter to work upon; to accustom it betimes to fall easily into a consistent and useful train of thought: but it appeared, from many things you said when last here, that this occupation is not new to you. I must in justice therefore refuse the compliment you make me. *Curiosity* is an excellent quality, which nature does not make so strong in the human mind, and especially in young persons, for no purpose: and I see, from the present instance, that it sometimes finds out its own way.

M. It will always be better for direction in any caſe, though I own it is a fine handle; and by it there is a certain dexterity, I conceive, in leading people, ſo that they ſhall ſeem to guide themſelves: this, I ſuppoſe, is the natural uſe you meant might be made of it?

P. I either meant it, or you have put a right meaning on what I ſaid at a venture.

M. Pray be a little more explicit; the point ſeems to deſerve it.

P. Things appear to me thus. We are at firſt innocent creatures, without experience, but with an unbounded ſtock of curioſity. The mind is then in the ſame ſtate as the body was in the womb, capable of being moulded either crooked or ſtraight. We are attentive to what paſſes within our obſervation. Hence the firſt examples have a prodigious influence upon us. They are the models held out to our imitation in like circumſtances. Theſe we muſt think juſt and natural, as we know not another way of action. What is told us we firmly believe, being without ſuſpicion and without art. From this you will ſee how early the human mind may be tainted. If after this we endeavour to reclaim young people, once thus perverted, only by the methods of *pain* and *terror*, we treat them not like reaſonable beings, and are ſevere on others for our own fault. If they ſhould eſcape this firſt danger, and the *infant-habits* of virtue (if I may be allowed the expreſſion) are once ſettled, that *ſtrong curioſity*, ſo natural to a mind unfurniſhed, gives us all the command over them we ought in reaſon to deſire. All the remaining part of life has leſs hazard in it (bating particular accidents) as the young perſon has now ſome ſtock, and can do ſomething in his

own

own defence: but a child is at the mercy of every bad example.——Thus much in compliance with your deſire. To purſue things more minutely would be needleſs.

M. From your beginning in this manner, I eaſily ſee through the whole; and it ſeems you charge the future miſcarriages of young people on the miſconduct of the old.

P. The more I may be miſtaken in this caſe, ſo much the better. But to return to our ſubject.—As you have been conſidering the objects that fell under your obſervation, what are your thoughts now of that variety of ſpecies and individuals which are wrought out of the ſame common dead ſubſtance?

M. If my capacity were greater, I find my admiration muſt be heightened in proportion: but concerning this particular, I have a queſtion to propoſe to you.

P. I ſhall be glad to hear it.

M. If the reaſon why the Deity hath ſhewn ſo much *power* and *wiſdom* in the fabrick of the univerſe, was to repreſent theſe perfections to rational beings legible in ſuch an inert thing as matter, and ſince we are not able to fathom the depth and variety of the contrivance, nor the extent of the power employed in the works of nature, pray tell me for whoſe uſe and contemplation are thoſe hidden miracles reſerved? Many of theſe in the cœleſtial bodies we cannot reach, becauſe of the diſtance; and many more, though near and round us, are as inacceſſible, becauſe of the multiplicity and concealed fineneſs of the art. And yet it muſt be inexpreſſibly pleaſing and inſtructive to the *rational nature* to ſee and admire theſe ſecret myſteries of wiſdom and power: and

therefore

therefore to wiſh to know them, ſeems not to be an idle curioſity, but a rational deſire. We can have no reaſonable deſires, I think, but what were deſigned to be gratified.

P. You put the queſtion pretty ſtrong, Matho; and it ſeems to import ſomething not commonly attended to. I agree with you, that ſuch retirement of art from mortal eyes cannot be without ſome great and rational purpoſe: we can diſcover nothing, as far as our faculties enable us to go, but what is uſefully and wiſely deſigned: and to imagine that all beyond our reach was void of purpoſe and deſign, would be an abſurd and injurious notion. I likewiſe agree with you, that the deſire of knowing thoſe hidden operations of the power and knowledge of the *Creator* muſt be rational: we are inevitably led into it as we improve our rational faculties. To this alone are owing all the late improvements in the knowledge of nature. It would be a ſtrange degeneracy in a rational being not to wiſh (at leaſt) to know thoſe diſcoveries, and after them others, &c. But it may perhaps be more proper to think of this afterward, in order to draw from it ſomething ſolid and juſtifiable in right reaſon.

M. Let it be ſo.——

LXXV. To purſue then the ſubject of our laſt conference; beſides the art in moulding and contriving ſuch a diverſity of things out of the ſame common ſubſtance, the manifold motions, which we ſee continually excited in them, ſeem to merit a more particular conſideration. I do not mean the motions of the heavenly bodies; theſe are ſo plainly the immediate work of the Deity, that no man can doubt about them: nor

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do I mean the leſs perceptible motions in vegetation, though theſe are more intricate: for there is nothing here except inert matter, no living creature to aſſiſt in producing the effect. But the motions of men, and all ſorts of animals, are extremely more difficult and perplexing.

P. If you are ſatisfied that matter reſiſts all change of its preſent ſtate, you muſt be equally ſatisfied that all motion is excited in matter by an immaterial cauſe.

M. I am fully convinced of it; but it is ſtill too general, and does not touch the caſe I want to be informed in.

P. I am afraid it will fatigue you, Matho, to ſpeak particularly of the ſpontaneous motions of animals, or even of that which is in vegetation; as a tedious diſpute would be raiſed on this head, which it is ſcarce worth while to enter into; and yet it requires ſome trouble to diſcuſs it.

M. You take the ready way to make me more inquiſitive; I would not willingly leave an objection behind me; and I thought I had already gone to the bottom of all diſputes concerning matter. Its inertia or inactivity is not denied.

P. Not directly; but ſome have had recourſe to the power of an *almighty being*, to beſtow on matter, if he pleaſed, not only the power of vegetation, but alſo of motion and thought.

M. It is meant, I preſume, that omnipotence could have made matter a ſelf-moving ſubſtance?

P. And a ſelf-directing ſubſtance too.

M. If it moves itſelf, it muſt likewiſe direct itſelf; the one includes the other: motion in no direction is not to be underſtood. And then, I ſuppoſe, it muſt be maintained, that every atom is an intelligent being: for power without intelli-

gence is but *mere temerity*; and *blind unguided motion* (as you ſhewed me before) could produce nothing but infinite diſorder and confuſion.

P. It is not ſaid that every atom muſt be an intelligent being; though the argument you advance muſt bring this hypotheſis, I think, to that concluſion.

M. If every atom does not direct itſelf by its own intelligence, it muſt be ſuppoſed to move itſelf by its own power, and to be conſtantly directed by a ſuperior power and knowledge. Does this ſave the Deity any trouble?——Beſides, every change of direction requires a force to be impreſſed, as much as the firſt exciting of the motion. Does not this ſuppoſe a force to be impreſſed on matter by an immaterial cauſe, while yet it is ſuppoſed to move itſelf, without an immaterial cauſe? This ſeems to be inconſiſtent. Could a body give itſelf the conſtant change of direction, in deſcribing a circular orbit round a center, on this ſuppoſition, more than if it were ſuppoſed void of ſuch power?

P. Things are not conſidered in this minute manner; nor is the ſuppoſition extended to the motions of the planets.

M. And yet the motions of the planets are far more ſimple and uniform than the motions of animals, or the motions in the vegetation of plants. If matter could perform by itſelf the latter ſort of motions, could it not much more perform the former?——And then might it not do all that is done in nature? And laſt of all, is this any thing leſs in its conſequences than laying aſide the Deity altogether?

P. But you do not conſider, Matho, that matter is ſuppoſed to be endued with this power by *an almighty being?*

M. But

M. But how does one, who thinks matter any way capable of all this mighty power, know that there is an almighty being, or any other almighty being than matter, if I may speak so without impiety? If we once suppose it possible that matter may do all that is done in nature, we lose after this all the arguments for the existence and providence of a Deity, taken from the order and government of the material world; because matter may do all this, and might have done it all from eternity: nay, we lose all arguments taken from any thing whatever, because matter may be a *thinking being*.

P. It is not supposed that matter may do all that is done in nature; nor is it intended to carry the argument so far.

M. If matter may have the power to form a *plant*, or an *animal*, or *to think*; what greater effects are done in nature? Nor does it depend on one who frames a supposition, to settle how far it should be carried; he ought rather to consider how far an adversary may carry it by legitimate consequences.

P. But still it is asserted that this power could only be imparted to matter by an *almighty being*.

M. Then you must prove an *almighty being* prior to this power, which is allowed possible in matter; that is, without having recourse to this power, which is just what I said before. You must likewise prove it utterly impossible that this power, which, it is supposed, may be in matter, should belong to the nature of matter itself. That is, as it appears to me, you must shew an inconsistency between the nature of matter and this power, and yet suppose them consistent at the same time, unless you would say that matter endued with this power loses its nature.

P. You

P. You have at laſt gained the point, Matho, and are certainly in the right. If we once ſuppoſe an *almighty being* to have endued matter with this all-performing power, we cannot, after that, make uſe of this power, which we allow may be in matter, as a *medium* to prove the exiſtence of that almighty being. This is called a *circle* in reaſoning; or the ſuppoſition that the Deity does this, is the only proof of his exiſtence in ſuch hypotheſis. Nor (as you ſubjoin) will they find it eaſy, after granting that this power may be conſiſtent with the nature of matter, to ſhew it abſolutely impoſſible to have belonged to the nature of matter originally. Which, nevertheleſs, is the only method they have left to ſhew a different origin of the power.

M. Beſides, this ſeems to me to ſet the almighty power of the Deity, and what I take to be demonſtrative truth, at variance. Would not appealing thus to almighty power affect all truth?

P. Carried to the greateſt height it would; but it is impoſſible to ſet the power of the Deity in oppoſition to truth. You may perhaps ſee hereafter, that to ſet the power of the Deity at variance with truth, would be to ſet the Deity at variance with himſelf.

M. To bring in almighty power then, where other proofs may be had, is to leave the methods of knowledge within our reach, and raiſe methods of knowledge above our capacity. This can have no other tendency than to keep the point from ever being determined.

P. The obſervation is juſt; it is by the light of the ſun we ſee all other objects: but looking directly at the ſun himſelf dazzles our eyes, and hinders us from ſeeing what we might perceive

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by his reflected splendor. However, as the supposition was rash and ill understood, it is needless to dwell longer on the examination of it.

M. Nay, Philon, I beg you would not leave it so abruptly. I have hitherto only seen the bad consequences of it, but not the formal way how to obviate them.

LXXVI. *P.* In order then to perceive the unskilfulness of appealing to almighty power in such cases, we must go a little farther back, and observe, that some of those people called *school-men* have been foolish enough to make it a question, *Whether the Deity could not perform a contradiction?* This, indeed, if true, would affect all truth, and introduce an universal scepticism, by calling in the help of omnipotence! For if a contradiction could be true, it could not be the mark of what is false; and we could not be sure but that it might be true in every case. Nay, two contradictory propositions might (for the same reason) be both true: and then every thing might be both true and false. In which case all truth is lost. This is the issue of bringing in *almighty power* to such a purpose! Now, with respect to such sort of suppositions, the case stands thus.——An almighty being can certainly perform whatever is the object of real power: but if the performance of any thing be repugnant to itself, or if one part of the performance supposes the non-performance of the other; as for instance, to cause that any thing should exist, while it is not; or to make a thing to be, and not to be, at once; or to make a *part* greater than the *whole*, of which it is only a part, *i. e.* to make it a part, and not a part, at the same time: I say, if the performance of any

thing be thus repugnant to itſelf, it is not the object of any power, but only an abſurd uniting of *inconſiſtent acts* in our conception; or rather, the expreſſing their union in our language; for ſuch repugnancies cannot be conceived.

M. This ſolution is both rational and ſatisfactory; for that would be to demand that the Deity ſhould not do a thing, while he does it; or make a thing both *nothing* and *ſomething* at the ſame time: an abſurdity more like the wild ravings of a delirious brain, than reaſon or common ſenſe.

P. It is, indeed, to bid the Deity, who is the *ſupreme reaſon*, ſhew himſelf abſurd, or make himſelf a liar, or deſtroy his own power, or contradict his infinite perfections, or join our folly to his own omnipotence. What elſe is it, when they ſuppoſe the ignorant inconſiſtencies of their own fancy the objects or the meaſures of infinite power and wiſdom?

M. And this ſilly miſtake, I preſume, is at the bottom, whenever we ſeem to doubt, whether the Deity cannot perform a contradiction?

P. You ſee it muſt.——Now, to come to the difficulty, if you can ſhew a repugnancy in the ſuppoſition, that matter ſhould of itſelf change its ſtate from reſt to motion, or from motion to reſt, or give itſelf a new direction, the thing is done, and you may juſtly infer, that whatever motions exiſt in nature were produced, or are renewed, by the power of an immaterial being, without leaving a poſſibility for a contrary ſuppoſition.

M. That, I apprehend, is, in effect, already done. It was ſhewn, that matter, inſtead of effecting a change of ſtate in itſelf, neceſſarily reſiſts all change of ſtate, as it is a ſolid ſubſtance; and that this reſiſtance to a change of its preſent

ſtate

ſtate is the only means whereby it can be made to do any thing, or be of any uſe in nature. For, when we ſuppoſed it not to reſiſt, we ſaw it could do nothing for want of force or ſtrength to continue in its motion, or in its reſt. It could ſuſtain no force or impreſſion, and therefore it could not gravitate, or have tendency to a center. Tendency to a center ſuppoſes a determined force impreſſed upon, and retained by it, which would carry it thither. It could not bear the ſhock, or the contact of other matter; therefore it could not ſuſtain that conſtant impreſſion which is in the coheſion of parts. Each ſide would yield to the impreſſion, or rather without bearing the impreſſion, till the whole ſubſtance diſappeared, or was really deſtroyed at the very approach of force; for the action in coheſion is that which effects the ſolidity of matter. So that ſolid ſubſtance itſelf does not remain on this ſuppoſition. There is nothing but the *phantom*, the *ſhadow*, the *name* left; ſomething as impaſſive, and as far from matter, as empty ſpace itſelf is. In ſhort, ſince all action of matter upon matter, or of *immaterial power* upon matter, ſuppoſes a reſiſtance between its parts, there is nothing here left, which immaterial power could work upon, or in which it could produce any effect; nothing remains in material nature to be *paſſive:* or rather, the material univerſe diſappears. The bodies of men, animals, and vegetables, all thoſe wonders you ſhewed me at our laſt meeting, are loſt: there could be no power in moving, no act in forming, ſuch an endleſs variety of different pieces of workmanſhip out of a ſubſtance which is not. Does not this ſuppoſition cancel all the inſtances of power, wiſdom, and good-

neſs, which led us into the knowledge of thoſe infinite perfections in the Deity?

P. It makes terrible work in truth; and you run the conſequences very juſtly.

M. The reſiſtance of matter, therefore, cannot be leſſened or taken away, without leſſening or taking away the ſolidity or uſe of matter. Contrarily, we ſee that the reſiſtance of the parts of particular bodies was powerfully to be increaſed and made ſtronger, that they might have firmneſs and ſtrength enough to ſerve for various purpoſes. I cannot forget the confuſions which you ſhewed me, in our firſt conference, would follow, if all bodies were hard in proportion to their bulk, or ſoft as they are little; or if all bodies were equally *brittle*, equally *tough*, equally *yielding*, or *fluid*. Now if there could not be different bodies, or bodies uſeful for different purpoſes, but by thus ſuperinducing different degrees of reſiſtance, hardneſs, or tenacity, above the *general reſiſtance*, which cannot be increaſed or leſſened, but with the ſolidity of matter: we may from thence ſee how neceſſary this laſt ſort of reſiſtance is, that matter might be fit for any uſe, or, in effect, be ſolid ſubſtance. From all this, and more that might be added, it appears to me, that taking away the reſiſtance of matter to a change of its ſtate, is ſuppoſing the ſubſtance itſelf to be deſtroyed.

LXXVII. *P.* You need ſay no more; the point is undeniable, and beyond controverſy.—— Now theſe things being premiſed, let me aſk you, could this ſolid ſubſtance, which thus neceſſarily reſiſts all change of ſtate (whether of reſt, or moving uniformly forward) *not reſiſt?*

M. It could not certainly *not resist* (if such manner of speaking be proper:) for this is to ask me, *If a thing could be, and not be, at the same time?* A contradiction in terms, the performance of which is not the object of any power, and could imply no perfection. That matter should not resist a change of its state, the substance ought to be destroyed: and if the substance were destroyed, surely it could effect nothing by not resisting.

P. But could not this resisting substance, by some means or other, effect a change of state in itself?

M. By what means do you conceive it might change its state? Unless your question were more particular, it cannot receive a distinct answer. And if the question cannot be put, without supposing a contradiction, it ought not to be put at all.

P. What if an *adversary* should say, that matter might change its state, not indeed by resistance, but by some contrary force or tendency?

M. What should give it this force or tendency? In what direction should the tendency to motion be? A tendency to move in all directions at once is absurd; and a tendency to move in one particular direction requires a determining cause. An effect without a cause is repugnant. Is it supposed to have this tendency *always*, or at *some times* only?

P. You are too particular and minute, in enquiring into every little circumstance.

M. Then, it seems, I must both frame an adversary's objection, and answer it.——Let us suppose then a contrary force or tendency in *matter*, and the consequences will be, that these

two contrary forces, the one of reſiſting a change of its preſent ſtate, and the other of changing that ſtate, ſhould have a ſtruggle in the ſame ſubſtance, which ſhould prevail; though, by the way, no man can, I think, conceive this poſſible. The ſtronger of theſe forces therefore muſt overcome the weaker, and ſo that one force only would remain: or if both forces were equal, they muſt mutually ſuſpend or deſtroy each other; and thus no force, not even that of reſiſting, would remain. Thus we ſee *that the ſame ſubſtance is not capable to be the ſubject of two contrary forces or tendencies*; and the reſult of the ſuppoſition is, *one force only, or none at all.*

P. What if they ſhould have recourſe to the *power of the Deity* at this *pinch?*

M. What is it they would demand of the Deity in ſuch a caſe?——That which reaſon denies them: that he would *do*, and *not do*, the ſame thing, at the ſame time, for their ſakes? For this is really their requeſt at the bottom. They join inconſiſtent notions in their own imagination, and then beg of the Deity that he would bear them out in this diſtreſs: that he would *ſet his power in oppoſition to truth* for once, to gratify thoſe who are ſo reſpectful as to appeal to his omnipotence. The Deity, as you ſaid, is the *ſupreme reaſon*, and not a *refuge* for abſurdity. Nor is it a ſimple abſurdity, ſince they contend, not only that a reſiſting ſubſtance ſhould *not reſiſt*, but that, while it reſiſts, it ſhould overcome its own reſiſtance: that is (ſince matter cannot admit a contrary force to this) that the *means* of overcoming its reſiſtance ſhould be the reſiſtance itſelf.

P. As it appears to me, Matho, you have ſifted the argument in all its ſhapes: however, let

let us ſuppoſe for once, if you pleaſe, that the *two ſtruggling forces* could, by ſome ſtrange power or other, be planted in matter; the *one* of perſiſting in, and the *other* of always changing, its preſent ſtate; that we may ſee the reſult of the controverſy on this ſuppoſition alſo.

M. With all my heart; though I fancy it cannot be brought to any other iſſue than before. For as both forces are ſuppoſed to act always, either the force of perſiſting in the ſame ſtate muſt prevail, and ſo the oppoſite force ſhould be without effect; or this laſt force muſt prove the ſtronger, and ſo the body could have no force to remain in the ſame ſtate, without a conſtant aſſiſtance from *ſomething immaterial.*

P. You brought the point to the ſame iſſue, I remember, in a like caſe before.

M. It was ſo; for they who maintain this ſuppoſition ſhould thus ſhift ſides in the debate; viz. refuſe an *immaterial power* to effect a change of ſtate in matter, and yet contend for an immaterial power, conſtantly impreſſed, to aſſiſt matter to remain without a change.

P. This would be extremely fooliſh to find in matter a conſtant power to change its ſtate, and yet no power at all to remain without a change: for if matter had any ſort of power, it muſt be that of remaining in the ſame ſtate, as a change of ſtate requires a different exertion of power.—— But pray, if this force of conſtantly changing its ſtate ſhould be thus prevalent, what muſt the conſequence be?

M. The preſent ſtate would inceſſantly be changing; or a body could have no ſtate, either of *reſt* or *motion*, but a continual turning from the one to the other; which, whatever way they might-

endeavour to explain it, muſt be inconceivable. For the order of nature, and conſiſtency of material things, require ſome certain finite duration of the ſtate of reſt, or motion. And as this conſequence would take away both *reſt* and *motion* out of nature at once, the thought is monſtrouſly repugnant.——

P. Laſtly, Matho, ſince the very ſolidity of matter, and therefore its reſiſtance (that is, its tendency to remain in the ſame ſtate) requires the conſtant impreſſion of *divine power*, as we ſaw before; we may ſee alſo that the various changes wrought in matter, are but the various modifications of the ſame conſtant impreſſion.

M. I ſee the ſtrength of the conſequence clearly, and with great pleaſure. For if the power of the Deity conſtantly put forth, be the very *baſis* of the exiſtence of matter; the various operation of that power muſt be the cauſe of matter, as changing the manner of its exiſting: or if the Deity be the conſtant cauſe of the exiſtence of matter, he muſt be the cauſe of its exiſting in different manners; that is, both of its motion and its reſt. What elſe in the univerſal nature of things could diverſify the operations of the power of the Deity, except the Deity himſelf!——I thought I had finiſhed the conſideration of the nature of matter before: but this different view of the origin and ſpring of motion; and being ſhewn how improper it is to appeal to the power of the Deity, where other proofs may be had; does more than reward the ſmall pains I have taken in going along with you.

LXXVIII. *P.* You will now ſee with eaſe and certainty, what we are to conclude concerning the

the cauſe of all ſorts of motions in nature, excepting the ſpontaneous motions of animals, which are indeed more various and intricate, as you obſerved, and require a difference of conſideration from thoſe of inanimate matter.

M. The cauſe becomes now too plain to admit of farther diſpute; and the inſtances of motion too many to be reckoned up. The ſeveral motions in the *heavens*, in the *earth*, in the *waters*, in the *clouds*, in the *air*, which we breathe, are the immediate work of the Deity. When we reflect that life, and the pleaſure of it, depend on the changes which thoſe motions produce, we cannot think upon them without the higheſt reverence and gratitude.

P. You have reaſon to ſay ſo, ſince any one ſpecies of motion could not be taken out of nature, without our feeling the change greatly to our diſadvantage. We little conſider that the *air* and the *water* might as readily ſtagnate, as be moved: reſt requires no variation of power. Theſe *elements* then would become *baneful* and *deadly*. If the vapours did not riſe, rain could not fall, nor ſprings flow, nor vegetation continue. As to the motions of the greater bodies in nature; every one will eaſily allow that our earth, for inſtance, might have had no motion at all, inſtead of thoſe two wonderfully-contrived motions, which we mentioned before, and which bring about ſuch pleaſant and comfortable viciſſitudes. Beſides all theſe, the life of man and beaſt conſiſts in manifold motions, conſtantly performed in the body, without their knowledge or participation: it is ſo eaſy to conceive after what manifold ways theſe might be interrupted, that it is miraculous how they are continued. If our life depended only

on one ſort of motion, we ſhould ſoon forget that we were dependent at all; when we ſo little remember our manifold, and really innumerable dependencies. So that I agree with you, *we cannot ſeriouſly reflect on the ſeveral ſpecies of motion in nature, without the higheſt reverence and gratitude.*

M. Pray let me know ſomething concerning thoſe internal motions conſtantly performed in the bodies of animals, without their knowledge and participation.

P. I canot ſpeak of thoſe things, Matho, of which I know ſo little, without injuring the ſubject; and therefore I cannot convey to you thoſe juſt and lively notions, nor raiſe in you that admiration, which the particulars deſerve.

M. I do not expect a juſt repreſentation of thoſe matters; but only ſuch general hints, as may let in the firſt glimpſe of light on the dark and ignorant mind.

P. Why then to huddle up the thing at once, all is motion in the animal body, from the firſt throwing in the *aliment* into the ſtomach, 'till it is at laſt, by various changes and as various ways, conveyed to all parts, in order to recruit and maintain the whole: nor even there does the motion ceaſe, for thoſe ſupplies are quickly thrown off again, and the parts are conſtantly to be ſupported in the ſame manner.

M. I remember you told me before, that *perſpiration* occaſioned a conſtant waſte and decay of the body, and I am apt to believe it. For if, in adult perſons, the parts were conſtantly recruited from the aliment, without loſs of what they had formerly received, they muſt ſoon grow to an enormous bulk, and become an intolerable burthen: and if they loſt nothing, they would not

need,

need, I think, any new recruit, or the animal require food.

P. What you ſay ſeems reaſonable; the former ſupplies are thrown off, whether the parts receive new ſupport, or not: you ſee how ſoon a perſon may be emaciated by ſickneſs or diſeaſe, and worn to a very ſkeleton. And either the ſolid parts of the body thus fly off by inſenſible perſpiration, or they muſt bear a leſs proportion to the fluids than is commonly ſuppoſed: for in ſuch caſes, the brawny, muſcular, and firmeſt part of the fleſh diſappears.

M. Methinks I perceive from this, how the body might be ſupported without food.

P. The *Author of nature*, Matho, can eaſily ſuſpend the courſe of nature, which he inſtituted arbitrarily, without receiving laws from the materials he wrought with. An immortal body is no more a paradox, than an immortal ſoul.——

M. But you made a wide ſtep, from the firſt throwing in of the nutritive ſubſtance, to its being at laſt thrown off in this manner: tell me ſomething of the intermediate changes and motions. What becomes of it after it is thrown into the ſtomach?

P. Being bruiſed with the teeth, and mixed with the *ſaliva*, it paſſes to the ſtomach, where it is digeſted.

M. How is digeſtion performed?

P. The groſſer parts of the food are ſtill made finer, by the conſtant *attrition*, or *rubbing* of the ſides of the ſtomach upon them; 'till by this action, by the natural heat, and fermenting juices, they are concocted and brought into a new form, fitter for moving through the narrow *meatuſſes*, which they muſt paſs, in order to be conveyed to the blood.

M. How is it known that the ſtomach hath ſuch a conſtant motion as this?

P. Such a motion is neceſſary in the ſtomach on another account; namely, for thruſting out the aliment, ſo digeſted, into the *inteſtines:* and *nature* attains more ends than one, by the ſame means. *Graniverous birds,* being without teeth, for comminution of the grain, ſwallow little rough ſtones and gravel to aſſiſt this grinding or attrition: it is this action (they ſay) which occaſions the pain we feel in hunger; and ſome have computed the force of the ſtomach in this action to be incredibly great.

M. By what means is this conſtant action of the ſtomach continued?

P. I might tell you of the *elaſticity* of its fibres; or their alternate relaxing and reſtoring themſelves; but it is the ſhorter way, to own I do not know.

M. And as inſtructive too, I think, as to tell me that the action of the ſtomach is owing to the action of its fibres.——What becomes of the digeſted aliment, when it is thrown out into the inteſtines?

P. It is thrown out gradually: the feculent and excrementitious parts are protruded, by *another conſtant motion,* along the various and mazy folds of the guts, to be at laſt quite thrown off; and by this action, the finer and nutritious ſubſtance is forced into certain ſmall veins (called *lacteal veins)* appointed for receiving it.——But here again, Matho, we are in danger of becoming too minute and particular; which is neither your buſineſs nor mine.

M. I ſhall have done immediately; only tell me what ſort of a motion this of the guts is?

P. You

P. You have obſerved an earth-worm when it creeps on the ground?

M. Often.

P. It ſtretches itſelf in length, and becomes ſmall, by extending its *longitudinal fibres*; and then contracts itſelf, and becomes groſſer, by dilating its *annular fibres*: ſuch a motion is that of the inteſtines, only it is equable and conſtant, ſo as to become *wave-like*, or *undulatory*. You may perceive it in ſome tranſparent animals, by the help of the microſcope: and certainly nothing can be more adapted, both for carrying the *fæces* gradually forward, and forcing the *chyle* (as it is called) or alimentary ſubſtance, to aſcend in the *lacteal veſſels*.

M. It is, indeed, wonderful, and kind, that a motion, on which our life ſo nearly depends, ſhould be conſtant. But why ſhould the inteſtines fold and turn ſo much, rather than go on in a ſtraight courſe?

P. They are about ſix times as long as the whole body; that is, about ſix-and-thirty feet in a man; and artfully folded up in a ſmall ſpace, for this very purpoſe, that all the nutritive ſubſtance, or *chyle*, might in ſome place or other be taken up into theſe lacteal veins, which are every where placed to receive it in paſſing.

M. This is a notable contrivance!——For I conceive theſe lacteal veins could not have been large enough to take it up all at once, or in one place, without taking up ſome of the *fæces* along with it; which muſt have obſtructed the end of their ſeparation.

P. So ſlender are theſe *firſt lacteals*, that they do not exceed the capacity of *capillary arteries*.

M. What becomes of the *chyle* after this? Or whither is it conveyed?

P. It is conveyed by thoſe numerous veins into one common *receptacle*, and thence aſcends by one paſſage to the *left ſubclavian vein* (as it is called) as a leſſer ſtream falls into a larger: and afterwards it is carried with the circulating blood, to all parts of the body.

M. I have ſeen the circulation of the blood, Philon, in the finny tail of a little *tad-pole*; and certainly it is a motion full of miraculous power! So many ſtreams of liquor conſtantly running in a ſpace not ſo large as a pin-head! What you ſaid was very juſt; *The microſcope is like an enchantment!* From what you ſay of the *chyle*'s aſcending to the left ſubclavain vein, I would aſk how a liquor can flow upward: but pray ſhew me firſt, in what manner this circulation is performed; for though I beheld this wonder with my eyes, I ſaw it but in one point.

P. To give you ſome imperfect idea of it you muſt know, that the blood is carried from the *heart* by arteries, and returns to it by veins. The *arteries* proceed from one great trunk, called the *aorta*, iſſuing from the left ventricle of the heart. This is divided and ſubdivided into innumerable branches, and capillary extremities, which terminate in all parts of the body, external and internal, wherever it is neceſſary that blood ſhould be conveyed, or the parts recruited. The *veins* begin where the capillary arteries end; that is, over all the parts of the body; and returning, unite ſtill in larger channels, till at laſt they all meet and form the *vena cava*, which opens into the *right auricle* of the heart.

M. Thus far I have a general notion.

P. The heart, from the firſt moment of life, to our laſt expiring, is in a conſtant alternate motion,

tion, of the conſtriction and dilatation of its cavities, which are called its *ſyſtole* and *diaſtole*.

M. I need not aſk you how this alternate action is continued for eighty or ninety years? I know what anſwer you would give me.——

P. At every conſtriction of the left ventricle of the heart, the blood is expelled with great velocity into the *aorta*, which you may inſtantly perceive in ſeveral parts of the body by the *pulſe*, of which there may be about fourſcore in a minute. And thus the alimentary parts of the food are carried by innumerable ſtreams to all the parts of the body, to recruit the waſtes occaſioned by perſpiration.

M. I conceive it plainly.

P. Having diſcharged this office, the blood returns again to the heart, and is diſcharged into its right auricle, while that is in its *diaſtole*, or dilatation.

M. But I want to know how the blood flows upward in the aſcending veins. Water is raiſed up to the atmoſphere in the form of vapour, which cannot be the caſe here.

P. This I cannot tell you. Many are the efforts that have been made, to find out a mechanical power for this purpoſe; and if they have ſucceeded, ſo much the better. Only thus much is certain, wherever a liquor runs upward, there are *valves* diſpoſed in proper places, opening in the direction of the flowing current; but which muſt ſhut if the liquor ſhould move backward.

M. All this is aſtoniſhing! Here is not one, but numberleſs circulations, conſpiring to form one great circulation!

P. Conſider this figure a little.——It is the

ſyſtem

ſyſtem of the arteries in the human body, or of as many of the principal branches of them as can be expreſſed without confuſion.

M. I ſee ſome riſing to the head, neck, and ſhoulders, and extending to the arms and hands; and others ſpreading over the body, and running down to the thighs, legs, and feet: they appear vaſtly numerous.

P. And yet the ten thouſandth part of them is not, and cannot be repreſented. Their capillary extremities cannot be ſeen in other circumſtances, than you perceived thoſe in the fin of the little animal.

M. It muſt certainly be ſo, if they terminate as numerous in every little point, as thoſe I beheld there.

P. There is by far more difference between the greateſt and the leaſt, than between the largeſt *navigable river* and the ſmalleſt *rill.*——Here is ſuch another figure, expreſſing the general poſition of the larger veins.

M. I obſerve in this almoſt the ſame order and diſpoſition as in the former; ſo that one could not know which were which, unleſs better informed of theſe things, than from mere verbal deſcriptions.

P. If then the body were tranſparent, or the ſenſe acute enough to perceive all thoſe innumerable ſtreams conſtantly flowing, *from all parts, and to all parts*; what ſort of a ſight do you think, or what various motions ſhould we behold!

M. The very thought fills the ſoul with ſurprize! The body itſelf would then appear a ſyſtem of ever-flowing currents, more various and wonderful than thoſe in the largeſt kingdom upon earth.

P. All this motion is as real as if we conſtantly beheld it with our eyes.

M. I have often thought, Philon, ſince I began to conſider theſe things, what ridiculous and affected creatures the poets are, who wiſh for a hundred mouths, and a hundred tongues, to help them to deſcribe ſome paultry fiction of their own brain: it is only in ſuch caſes as theſe, where one could reaſonably wiſh that one's thought and admiration were a thouſand times doubled, to be able to purſue *every wonder*, and think worthily of the power and wiſdom manifeſted *in any* of the works of nature.

P. The occaſion would be more juſtifiable, I confeſs. But we muſt leave this ſubject, without conſidering the remaining part of the circulation; for we have only yet ſpoke of one half of it.

M. Pray what other half remains?

P. The ſyſtole of the right auricle expels the blood into the right ventricle; and the conſtriction of that cavity thruſts it into the *pulmonary artery*; on the *lungs* it is ſpread innumerable ways, and returns by the *vena pulmonalis* into the left auricle, by the ſyſtole of which it is forced into the left ventricle, whence it is again ejected into the aorta, as at firſt.

M. What is the uſe of this ſhorter excurſion of the blood from the heart to the lungs?

P. Though all allow it neceſſary, the uſe is diſputed; it ſerves probably more ends than one. The blood was to be impregnated with freſh air, which, by the great preſſure on the lungs in reſpiration, ſeems to be forced into it.——The *reſpiration* itſelf every body knows to be another *great, neceſſary*, and *conſtant motion* in the body, on *which our life* no leſs depends, than on any of the *other motions* we have mentioned.

M. The

M. The conſideration how life is preſerved, and how many different conditions are neceſſary, is full of awe and wonder! I perceive the truth of your obſervation; that *if our life depended only on one ſort of motion, we ſhould ſoon loſe all ſenſe of our being dependent creatures.*——But,

LXXIX. Pray in the next place communicate to me ſomething concerning *ſpontaneous motion.*

P. I muſt firſt acquaint you then, that thoſe motions we have juſt now been ſpeaking of, where the Deity is the *ſole mover*, and which are ſo artful and regular, may be called *mechanical*, to diſtinguiſh them from ſpontaneous motions, which are performed by men and other inferior animals.

M. I perceive the uſe of the diſtinction. You call this ſort of motion *mechanical*, not as if it were the effect of mere matter, without an immaterial mover (which is the common acceptation of the word) but to mark the juſtneſs and regularity of it.

P. For that reaſon only.——Now, I aſk you, ſince matter cannot change its ſtate, nor move itſelf; what are we to think of ſpontaneous motion, or concerning the *movers* that excite it?

M. This ſeems to me another eaſy conſequence from the inactivity of matter: for if mechanical motion be above the power of matter, ſpontaneous motion, which riſes above the laws of mechaniſm, is a degree higher above the power and genius of matter, and ſhews plainly that there is in every individual animal, or ſpontaneous creature, an immaterial principle, which is called the *living ſoul*, by which theſe motions are performed.

P. You have touched upon a fundamental conſideration, which will help to clear up this diffi-

cult affair by degrees: for in the motions we have hitherto taken notice of, the Deity hath reserved both the *power*, and the direction of the motion entirely to himself; or rather (to speak more truly) there was no other being which could be the cause of this motion: therefore the laws of mechanical motion are constant, and the effects of it infinitely fine and regular. But as the scale of beings was to rise, spontaneous motion (produced by living beings) was indeed *necessarily* to be less regular, and to produce less wonderful effects: and yet, so far as it receded from the stated laws of mechanism and regularity, so much the more doth it shew to us a different cause of motion, not only from dead matter (which is no cause) but from the Deity himself. And those creatures which are least perfect have so much the more of regularity in their works, as there is more of the Deity in those productions, than in those of superior animals.

M. Instances of this you shewed me at our last meeting; and now I see that *spontaneous motions* are so far distinguished from *mechanical* (i. e. those produced by the Deity) as they are more wild and irregular: or the power of the *spontaneous mover* is not conducted by equal knowledge.

P. You are right; this want of knowledge is a wonderful ingredient in our spontaneous motions; so far, I mean, as they are produced by us. The Deity hath granted animals a degree (a small degree) of power; but hath reserved the knowledge of the method entirely to himself. When we excite motion in any part of our body, we act as blindly as the brute creature. We attain at length a habit of moving one part, rather than another, according to our pleasure; but

know

know nothing of the ſecret means by which this is effected. The greateſt philoſopher on earth is, in this reſpect, on a level with the inferior animals.

M. I never reflected upon this before; and yet the truth of it muſt be perceived, as ſoon as attended to. We perform theſe motions before we know any thing; and the brute performs them as well as we. And when we come to know more, that does not teach us to perform them better. All is indeed a habit, we cannot tell how acquired: for the brutes ſeem to be ſooner maſters of it than man.

P. You reaſon juſtly; and we may likewiſe be farther convinced that our own knowledge has no ſhare in the production of ſpontaneous motion, in that when learned men have applied themſelves with all their induſtry, to diſcover in what manner it was performed, how the command of the will is ſo juſtly executed, or by what means the action comes to be communicated to the immediate inſtruments of motion, they have been able to do little more than gueſs ingeniouſly, and often in contradiction to each other.

M. This is really wonderful, and ſhews us, I think, that *ſpontaneity* and *knowledge* are very diſtinct principles.

P. You cannot make a juſter obſervation; and the longer you dwell upon this ſubject, you will find it the more confirmed. The brute ſpecies, as you obſerved, are ſooner perfect in ſpontaneous motion than man: and certainly we may allow, without danger of going too far, that they are not quite ſo knowing.——Now from theſe broken hints, you will at length be able to obſerve, *That by far the greateſt part*, even of ſpontaneous motion,

is produced mechanically; and that the imperfection we found before in ſpontaneous motion, is not in the mechanical part of it, but only conſiſts in this, that our ſpontaneity is not directed by equal knowledge. When I move my hand, the *muſcles* (as they are called) which produce the mechanical part of this motion, act as regularly as the muſcle of the heart, in its ſyſtole and diaſtole, where I have no participation: yet I cannot produce any ſuch artful effect as the bee, the ſpider, or the ſilk-worm.

M. That part of the motion muſt be mechanical, with reſpect to us, ſince it is not performed by our knowledge and direction.

P. Nay, nor by our power neither; for as we do not underſtand the contrivance, ſo we do not afford the means; and a ſmall diſorder of the mechaniſm, we find, hinders the production of the motion. So that when I move my hand, I as little ſupply the motive power, as I do the motion of my heart; and that is, as little as I do to the vegetation of a plant.

M. This ſubject becomes more wonderful at every ſtep! Here I ſee again, what we obſerved before, when ſpeaking of matter, that the Deity occurs to us in every thing, and his power is the ſpring of every effect. It is above expreſſion ſtrange, to find it at the foundation in our ſpontaneous motions.

P. It muſt be ſo in true philoſophy, Matho; if it appeared otherwiſe, I ſhould ſuſpect you had reaſoned wrong.——And yet, notwithſtanding this, it is certain that the *ſpontaneous*, or *living being*, both begins, and ſtops the mechanical motion, and determines all manner of ways, at its pleaſure. This we are intimately conſcious of,

and know we are endued with ſuch command. When we diſcourſe together (to paſs by other inſtances) the *ſpontaneous principle* commands the motions of the organs of ſpeech, in the articulation of every ſyllable: ſo that the words formed by this motion and the internal thoughts of the mind correſpond, as if the whole were performed by the ſame *agent* and *power*. We can ſcarce conceive a more eaſy and abſolute command, than the *ſpontaneous being* hath over the motion of the body in this caſe.

M. Indeed the command is ſo eaſy, that the greateſt part of mankind, I perſuade myſelf, fancy the whole action to proceed from the ſame cauſe: ſo eaſy, that the ſpontaneous being impoſes on itſelf! And is at the ſame time quite ignorant how the motion is performed! This is wonderful! Nor is it leſs wonderful that the Deity ſhould ſubmit his power to co-operate with the *ſpontaneous principle* in every living creature!

P. You ſee his condeſcenſion in the formation of the body of every the minuteſt *inſect*; and in the ſolicitous proviſion he makes for the moſt contemptible *reptile*. But theſe thoughts would carry us a great way. He co-operares with all the actions of men: the eſtabliſhed courſe of nature muſt otherwiſe be inceſſantly ſuſpended; and yet the *obliquity* and *error* proceeds from our thought and intention only.

M. I perceive there could be no ſettled courſe of nature, without this *co-operation*.

Si, quoties peccant homines, ſua fulmina mittat,

is applicable here: and the intention would not be leſs criminal, though the courſe of nature were conſtantly changed or ſuſpended, to prevent the effect.

P. This is a case then, where both the wisdom and the goodness of the Creator is conspicuous; and yet his justice, as our *law-giver*, hath full power to punish.——As to the ready command which the *spontaneous being* hath over the motions of the body, without knowing how these motions are performed, it is certainly wonderful: but we may easily be satisfied that the thing is so, from a case in some measure parallel. A man, by the help of machinery, or engines, performs far greater things than he could otherwise do; and if we suppose him ignorant of the contrivance or art, whereby the machine is made to perform the effect, but had only learned to move a handle, or certain part, by which the whole was set a-going, neither the power nor the knowledge of producing the effect belonged to him: and yet it could not be denied but that the man, by spontaneously moving this handle, or holding it still, had the command over the whole mechanism, and over the effect it produces. Just so, the *living being*, though ignorant of the contrivance and mechanism by which spontaneous motion is performed, both begins and stops it, and has a free command over it.

M. This I perfectly comprehend. A man who knew nothing of music, might for all that play a tune, or half a dozen of tunes mechanically, on an instrument so contrived, merely by turning a handle. Which shews that a spontaneous being may have the full power of exciting, continuing, repeating, or stopping a mechanical motion, which it does not understand. Here the *mechanical* and *spontaneous* powers are quite different, and the effect depends on both powers acting jointly: for in this instance, the tune could

not

not be played, if either the man did not move the handle, or if the mechaniſm happened to be diſordered.

P. It is very rightly obſerved. Now, as there are two ſeparate and diſtinct principles here, concurring to the production of ſpontaneous motion; ſince matter is devoid of all power, we ſee plainly that both muſt be immaterial, and alſo that the power and knowledge of the *one* is infinitely ſmall in reſpect of that of the *other*.

M. The conſequences of both are very clear. This conſideration of two ſeparate and diſtinct powers pleaſes me extremely, and agrees to appearances, as it aſcribes the different parts of ſpontaneous motion to proper cauſes. The ſoul could not produce the mechanical parts of ſpontaneous motion, and know nothing of the contrivance by which itſelf wrought: nor could the Deity produce the ſpontaneous part, and be impeded by a defect in the mechaniſm; nor could he feel the pain and impotence which the ſoul ſuffers under ſuch an impediment. Whence is diſcovered the extreme difference betwixt the two motive powers. If we admit but of matter, and *one mover* only; the motions of animals are quite unaccountable.

P. And therefore (as you obſerved in the beginning) the argument concludes for an immaterial principle in every living thing, brutes as well as men: though there are other arguments, not applicable to the ſouls of brutes, which ſhews ſeparately, and upon other accounts, the immateriality of the rational ſoul.

LXXX. *M.* Since both are immaterial, I ſhould be glad to underſtand the difference between the brute and human ſoul.

P. This

P. This is a point, Matho, the diſcuſſion whereof, as I obſerved to you before, is extremely difficult; for though the anſwer to your queſtion might be given in few words, yet opinions entirely contrary to each other, and equally abſurd, have ſet men on perplexing, inſtead of unravelling the ſubject. Some philoſophers will not allow the brutes to have ſo much as a ſpontaneous or living principle in them; and others will needs raiſe them to the dignity of rational beings.

M. Theſe are in truth very contrary opinions; but ſo far I think appears already, from what has been ſaid before, that ſpontaneity and knowledge (or reaſon, as I take it) are very different things.

P. As different as moſt things you can name. Few creatures are defective in ſpontaneity, after we paſs thoſe, which, like plants, are rooted to ſome place: but reaſon is a thing of a ſuperior nature. In man himſelf, the latter of theſe principles is not near ſo extenſive as the former.—— But to come to the point itſelf, we might leave both the contending parties to fight it out, were it not for the conſequences which are applied to the human ſoul. We have juſt now ſeen how groundleſs their opinion is, who deny brutes to have an *immaterial principle:* and if we would examine appearances fairly, we could not find juſtifiable arguments to conclude them rational beings. It is plain the human ſoul has a ſuperior power to that of brutes; and if we ſhould call that power (whatever it be) *reaſon*, the controverſy would be at an end.

M. This makes ſhort work; and ſure I am that man would be reckoned irrational, and unfit for the converſation of his ſpecies, who had not more reaſon than the moſt perfect brutes; than

the *dog*, the *ape*, or the *monkey*, which you reckoned to come neareſt to the confines of reaſon.

P. The obſervation is extremely juſt; and from thence it muſt appear an affected partiality to ſuppoſe that the *ſame talents* ſhould make a man *brutiſh*, and a brute *rational*. It is even contradictory to itſelf; for while it would bring down man to the level of brutes, it ſuppoſes that more is expected from him as a rational being: and why ſhould more be expected from him as a rational being, but on the ſuppoſition that brutes are without reaſon?

M. This is a plain inconſiſtency.

P. However, that we may ſearch into the foundation of their miſtake, pleaſe to obſerve with me, that reaſon is a *ſelf-improving* power or faculty of the ſoul, by which man is capable of great advancement: and when he neglects to improve his nature, he becomes indeed brutiſh with reſpect to the reſt of his ſpecies. But ſtill this ſhews the dignity of reaſon above the endowments of brutes, which, rightly cultivated, ſo eminently advances the human nature; and it is but poor ſophiſtry to run the compariſon in this ſtudied inequality. It is ſaid, *Man differs more from man, than man from beaſt.* Let it be ſo; let the obſervation be as juſt as they pleaſe: the more true it is, the more it makes againſt themſelves; for it allows that *reaſon improved* is doubly elevated above the brute nature.

M. This ſeems very plain; and the only fair method in this caſe would be, I think, to ſet the moſt perfect of the brute ſpecies, in compariſon with the moſt perfect of the human; which would ſhew the difference of the ſpecific faculties in a *true* light.

P. That

P. That would be to give up the queſtion at once. We can hardly imagine the height to which human reaſon has arrived in ſome men; in a Socrates, a Plato, an Archimedes, a Newton.

M. Pray let me interrupt you, to aſk, who this laſt man was? I have often heard him named, but never without admiration.

P. He was the glory, Matho, not only of his nation, and of the age he lived in, but the ornament of the ſpecies itſelf; whoſe wonderful diſcoveries have advanced true philoſophy more, and taught us better to admire the power and wiſdom of the Creator in the works of nature, than thoſe of all the philoſophers that went before him, or, I am afraid, will come after him. But for me to enter more particularly on his character, would be doing myſelf honour, but that incomparable perſon none.——To return, if we conſider, on the one ſide, the amazing improvements the rational nature is capable of; and on the other, that the nature of the moſt perfect ſpecies of brutes is ſtrictly confined to a *certain limit*, beyond which no art or induſtry of man can raiſe them; it ſeems to point out to us, that the ſpecific perfections differ not only in *degree*, or more and leſs of the ſame faculty, but in *kind*; or that they are powers of different ſorts.

M. It is ſtrange enough, that all of the ſame ſpecies of brutes ſhould keep ſo conſtantly to the ſame train of action; or if they be rational, that they diſcover no new improvements, nor riſe ſome of them above others, as we ſee it is among men: and it is but a bad ſign, that they can neither improve by their own induſtry, nor by the aſſiſtance of mankind.——

P. In the next place let me obſerve to you,

that man may not only not improve his reaſon, but pervert this improved faculty to vicious purpoſes; and then he becomes a *more terrible monſter*, indeed, than any in the deſerts of Africa: and that this degeneracy is not obſervable among brutes ſhews only a nature nearer to mechanical, and more confined.

M. I ſee the force of the conſequence; the leſs power a creature has to act, the more uniform and regular its actions muſt be.

P. Yet this affords thoſe, who willingly miſtake, a large field to decry the rational nature, and exalt the brutes as the more perfect beings. It is a true obſervation, *That the corruption of the beſt things becomes the moſt hurtful:* but it can be no good argument to infer from this, that therefore the beſt things are the worſt; ſince the truth of the obſervation depends on their being naturally preferable. *Freedom*, or a power of *ſelf-determination*, is a high privilege, without which there could be no virtue in the beſt actions, nor improvement of our nature in any reſpect.

M. It is ſo; for if I am compelled to do a laudable action, I juſtly loſe the merit of it, as it proceeds not from a right diſpoſition of mind. And if a creature hath but one way of acting, the action can neither be reckoned virtuous nor vicious.

P. That is what I was ſaying: there can be no merit in brutes not degenerating, or in their ſteadily purſuing one train of action, from which it was not in their power to deviate.

M. And ſo on the contrary, when a brute creature does a hurtful action, it is not reckoned criminal or guilty; though a man for the ſame action would be puniſhed, perhaps with the loſs of life.

P. It

P. It is justly observed: in such cases the common sense of mankind construes them not to be rational, but merely sensitive creatures. And it is remarkable here, that a *madman* is not reckoned accountable for his actions, on this very account; namely, because he is without the use of reason. Which seems to be a plain confession, that brutes are not rational or moral agents: for if an accidental or temporal incapacity deprives a being of that denomination, a constant and natural incapacity ought much more to do so.——

M. You infer, therefore, the superiority of the human above the brute nature, as well from the *corruption*, as from the *improvableness* of it?

P. Doth it not appear so to you?

M. I own I am satisfied that this equality among brutes, and their not degenerating, is not owing to a right use, but an utter want of power in the brute soul.

P. We ought then to blame the man, who might have made a better use of his reason, and not find fault with the power which he abuses: whereas we justify the man, by laying the blame upon the power; that is, in reality, upon the Deity, who bestowed it. In short, there is a complication of false reasoning in this case: we suppose, and admit, that the necessary nature in brutes is a moral perfection in them; then we condemn the moral corruption and degeneracy of man, as a physical imperfection in his nature and constitution: and from this double fallacy, we exalt the brute nature, to the disparagement of reason.

LXXXI. *M.* I was pretty well convinced in my own mind before, that brutes are not rational

creatures, and am farther confirmed in my opinion from theſe two conſiderations you have pointed out, viz. that their natures cannot be improved to any rational purpoſe, and that they are not liable to the degeneracy of mankind: but what ſhall we ſay to many particular inſtances, which are really ſurprizing, and are brought to ſhew that they reaſon in *ſome caſes?*

P. Thoſe very inſtances, Matho, render that ſide of the queſtion extremely improbable. Why elſe ſhould they argue from a few, ill-atteſted particulars, which do not hold when put to the trial? The appearances from which we might with certainty conclude, that brute beaſts are rational, ſhould be univerſal, and liable to no exception. If brutes reaſoned in *ſome caſes*, what ſhould hinder them from reaſoning in others? And after all, what is it that makes thoſe inſtances ſurprizing, but becauſe little is expected from them? If they were thought rational, the appearances alledged would be looked upon as ſhamefully trifling, and from the purpoſe: nay, ſo ſilly are they, that they would then be brought as inſtances of their ſtupidity.

M. I am afraid you will cut off the objections I had to offer, by theſe previous conſiderations; the reaſonableneſs of which notwithſtanding I cannot help owning.

P. By no means: propoſe your objections.

M. What do you think of *parrots*, *magpies*, *ſtarlings*, and other birds, which are capable of being taught human language?

P. You yourſelf muſt certainly perceive, that this inſtance is nothing at all to the purpoſe. The *gold-finch* alſo imitates the *lowing* of a bull, or the *neighing* of a horſe, as Pliny obſerves: a parrot

parrot imitates the barking of a dog, or, indeed, any noiſe. This is mere imitation of ſound. They imitate alſo articulate ſound, but without underſtanding the ſenſe. When parrots learn to pronounce the words *whore*, or *cuckold*, they cannot have the very complex ideas which theſe words excite in us. Children themſelves learn language at firſt in a manner perfectly mechanical: there is no connexion, either natural or rational, between the word and the thing ſignified. And when a bird learns to imitate the ſound, I cannot ſee how the knowledge of the thing ſignified can be communicated to it.

M. Some birds learn a tune very diſtinctly; which ſhews that they have both memory and an ear.

P. They imitate a tune pretty diſtinctly for ſuch creatures: but an ear is a thing merely mechanical, even in man, and no effect of reaſon at all. If you hear a tune often ſung or played, ſome parts of it will return upon you afterward, without your endeavour to recover it; and in time the whole of it will return upon you, and ſtick with you, in the ſame mechanical manner. When this is ſo in us, it cannot be otherwiſe in them. We endeavour to hit the note purely in this mechanical way, and not by memory or judgment: and when they endeavour to hit the note, it cannot be, I ſuppoſe, in a more perfect manner.

M. I begin to ſuſpect, indeed, that a *good ear* is a thing purely mechanical; and that he who has a better ear, has not always either a better memory or more judgment than another.

P. We might here obſerve, Matho, that the whole effect of muſic upon man himſelf is a thing entirely mechanical, and has nothing to do

with reaſon: it is thus that ſeveral ſorts of muſic excite different paſſions in us; one air makes us languiſhing and ſad, and another briſk and gay. And the learned are of opinion, that nothing is harder to be accounted for than theſe various and violent effects. What reaſon can be given why a certain compoſition of ſound ſhould put *one man* in a rage, without affecting *another* any way? Now no body will deny, that theſe animals may have any mechanical affection in common with man; for that has no ſort of affinity with reaſon: and yet it would be a wide ſtep in argument to infer from this, that the ſame tune has the ſame effect upon the bird that learns to imitate the ſound, that it has upon you or me; ſince it is poſſible that we may be very differently affected by it. In ſhort, ſince they imitate indifferently whatever tune they hear, without preference, I ſcarce think they underſtand the harmony or fineneſs of the compoſition.

M. Since this imitating faculty has no choice, they do not ſeem to perceive the harmony at all, unleſs we ſhould ſuppoſe that they perceive harmony in the lowing of a bull, or barking of a dog. We ought, I think, to reaſon with more caution and exactneſs, in ſuch caſes, than generally we do. ——But certainly ſome creatures are taught to perform ſtrange tricks.

P. They are ſo: but the mechanical methods which are taken to teach them ſhew, that they deal with ſenſitive animals, and not with rational beings. Upon a *word*, or a *ſign*, the repeated good or bad treatment is brought in view; and thus at laſt the *ſign* and the *trick* become mechanically joined. This is extremely poor for a rational creature! Nor can it be ſaid that this is for want of underſtanding

ſtanding our language: people that are born both deaf and dumb want language as much as the brutes, and yet act very conſiſtently, and ſhew a ſurprizing ingenuity in learning many things.

M. This I did not reflect upon before, and I believe I muſt give up the cauſe. Brutes certainly have an advantage over thoſe perſons who neither hear nor underſtand language: ſo that though language be extremely proper and helpful to rational creatures, I ſee it is not that which makes us rational; nor therefore doth the want of it hinder brutes from being ſuch. The imperfection lies deeper.——But I have heard of an ape which played at cheſs.

P. Theſe are *common-place ſtories*, Matho; we ought to proceed as cautiouſly here, as we do in experimental philoſophy. People muſt be ſatisfied that the experiment holds; they will ſee it tried themſelves, and weigh all circumſtances, before they draw any concluſion from it. I could tell you many ſuch ſtories: but it is time to leave the argument when it dwindles into fable.

M. I propoſed the ſtory in joke only; though thoſe ſtories are ſometimes more than common-place ones; they grow very particular, and people are affronted if you pretend to doubt what they have been eye-witneſſes to, or had from good hands.

P. Then it is not good manners to diſpute the point; though it would be too much complaiſance to allow that a ſtory of this kind decides the queſtion.

M. What you ſaid at the beginning ſeems extremely reaſonable. The appearances ought to be univerſal, and liable to no exception, from which we could conclude with certainty, that

brutes are rational. To ſay they reaſon at *ſome times*, appears equal to ſaying, they reaſon not at all. I have often thought, on hearing thoſe ſtories in company, that the perfecteſt brutes do a thouſand actions which ſhew they are void of reaſon, for one that could be any way conſtrued to be the effect of ratiocination: ſo that, in referring to appearances, the moſt perfect of them muſt be reckoned a thouſand times more abſurd than rational. This confounds all; for why ſhould their reaſon come and go, by fits? or not anſwer them on all exigencies alike?

P. You are certainly in the right: reaſon is an univerſal faculty, and applicable in all caſes where the difficulty is but equal: even where it is greater, reaſon ſuggeſts that they ſhould at leaſt doubt and deliberate. And when we obſerve all ſpecies act with amazing juſtneſs and ſagacity, in caſes that concern the *preſervation of the individual*, or the *propagation of the ſpecies*; and yet in other eaſier caſes behave with incorrigible abſurdity; we may fairly conclude that they are void of reaſon, and act from another principle in *theſe two caſes*.

LXXXII. *M.* From what other principle? Or how ſhall we account for the wonders they ſteadily and conſtantly perform in theſe caſes? For there are no ſtories here; but every man may be ſatisfied from his own obſervation.

P. What creatures are they which perform the greateſt and moſt conſtant wonders?

M. Why, the very leaſt animals do that which is moſt ſurprizing. The *bee* is a pregnant inſtance of inimitable art; no body needs indulge fancy here, or tell a ſingular inſtance which happened at ſuch a time, or in ſuch a place; every thing is miraculous.

miraculous. The *spider*, the *ant*, the *silk-worm*, and all those *insects*, which pass through two or three states of existence, raise our admiration. *These last* act as if they had a full and comprehensive view of all the transformations they were to undergo, and knew what creatures were to rise from the spoils of their bodies, which they so carefully entomb for that purpose. In their last state they repositе their eggs for another circulation of animals, as if they understood the nature of plants, and saw through the whole process of the future vegetation.

P. You owned, when we were speaking on this subject before, that these little animals wrought consistently in this mysterious process, without knowing what they did.

M. The same reasons shew me still, that they work blindly, and yet consistently. I rest satisfied, that the bee knows nothing of geometry, though the cells she builds are noble instances of the knowledge of that science: nor do the birds of passage keep an almanack, though they rendezvous from all parts of the country on a certain day; nor have they any chart of the country they are going to, or compass to steer their course by. Now it is this paradox, or mystery (shall I call it?) of *working artfully without knowledge*, which I would have you unfold.——

P. Before we come to that, pray take notice, that those creatures which perform the greatest wonders are certainly not endued with reason. This, rightly attended to, takes off the whole probability from their side of the question, who would have the inferior creatures rational; since the things which require reason and knowledge most in them are performed by them without

either. For if we are certain that theſe perform what is moſt difficult from another principle, it would be humourſome and fooliſh to contend, that what is leſs difficult could not be done without the rational powers of the human ſoul.

M. I perceive, indeed, from what you obſerve, the weakneſs of that whole pretence. The *bee*, not to mention her work, ſeems to act more wonderfully in travelling out ſome miles to the heath to gather her honey, and returning regularly to her own home again, than the *ſpaniel* does in caſting round the field to find out the ſcent of the fowl: and to contend that the dog could not do this without reaſoning in his own mind, while the inſect does more, ſeems really no more than humour.——But pray inform me, on what principle do theſe little creatures act?

P. Before I can do this you muſt tell me, Who teaches or inſtructs the *young* of larger animals, the *lamb*, the *calf*, the *puppy*, &c. to ſuck their dams? This is a common inſtance, and without ambiguity. They never ſaw an example of this to copy after. Who informed them that a certain liquor was proper food for them? That this liquor was to be found in the body of their dams? Or how to apply for it? Who inſtructed them in the art of ſucking, the principle of which was not known to philoſophers till late? Yet they go readily about this work the firſt thing they do.

M. Nature inſtructs them in all this.

P. Very well! Nature inſtructs all theſe leſſer creatures then, of which we were ſpeaking, to perform all theſe miracles of art, which you ſo much admire.

M. But I do not know; this does not ſatisfy me.

P. You

P. You have as much reaſon to be ſatisfied with my anſwer, as I have to be ſatisfied with yours.——What do you mean by *nature?*——

M. To deal plainly with you, I do not very well know; but this is the account I have often heard given.

P. Does this account ſatisfy you?

M. When I begin to examine it more narrowly, I find it is nothing but a *word*, which ſhifts off the conſideration of the point: and the inſtance is ſo common, we never think it worth while to reflect upon it.

P. Conſider it again, and tell me, Whether any inſtance, which is brought to ſhew that brutes reaſon, be more wonderful than this very firſt action of theirs?

M. It is both more wonderful and better atteſted than any inſtance I have heard alledged.—

P. Come, tell me, Who teaches the *young* of all animals, without exception, firſt to make uſe of their limbs, and move their bodies? As we obſerved before, this is a ſecret to all the philoſophers on earth, how ſpontaneous motion is performed. And how can every brute, every creature, ſo readily perform an action, the nature and reaſon of which is ſuch a myſtery! Who guides them in this work?

M. I ſaw before, that both men and brutes are ignorant how ſpontaneous motion is effected, but did not attend to any difficulty in it.

P. There is the ſame difficulty here, as when a little inſect works blindly, and yet conſiſtently: for it can never be ſhewed that ſpontaneous motion is performed by reaſon, nor by habit either, in the firſt inſtance. Conſider how complicated a machine the body is; the motion of every part requires

quires a different touch: and yet not only the lamb, or the calf, but the *little chick*, hardly excluded the ſhell, touches every part of the mechaniſm *artfully*, and *without heſitation*. To ſee a little bird run nimbly from you, with ſome part of the ſhell ſtill ſticking to it, is, if you reflect on it ſeriouſly, a more aſtoniſhing inſtance, than if you ſaw a perſon play ſkilfully on a ſpinet the firſt time he had ever ſeen one.

M. You give me a view of the whole wonder in this. It is fooliſh, I perceive, to be peremptory, that the actions of brutes are performed by their own reaſon, when we do not know on what principle ſuch a common action as ſpontaneous motion is at firſt performed by ourſelves. And as to a *habit*, the firſt practice in other creatures ſeems equal to the perfection of a habit. No body, I believe, thinks there is any difficulty in this, that a lamb newly yeaned ſhould riſe from the ground, and walk about its mother; though it ſees its dam walk, that is all internal and hidden work to it.

P. Once more, Matho, for I muſt ply you cloſe with queſtions, tell me who guides the *peach-tree* to produce a *peach*, rather than a *pear*, or an *apple*, or a *cherry*, or a *gooſe-berry*, or any other kind of fruit? For you remember that different ſorts of trees may be grafted on the ſame ſtock; and ſo the different ſorts of fruits have but one common matter to be wrought from: and that the pulp or fleſh of the peach, the ſkin, the kernel, and even the ſtone itſelf, were but a few weeks before in the form of ſap: and laſtly, ſeeds, you know, are not like *moulds*, to direct the unſteady hand of the workman, but are themſelves originally formed without mould or pattern.

LXXXIII. *M.* Right, Philon!——Give me time to recollect a little.

P. Conſider the point at your leiſure.——

M. This ſhews me ſeveral things at once. There can be no miſtake here. I ſee by whoſe art this muſt be done, where there is no living creature to aſſiſt in the effect. The conſtant direction of the Deity is neceſſary in this caſe; and it is no leſs neceſſary in the formation of all animal bodies, than of vegetables: and farther, when theſe little creatures have no faculties to contrive, nor knowledge to comprehend, the myſterious proceſs they are employed in, it is ſtill equally neceſſary, and equally plain, that they muſt be guided by the ſame wiſdom, which conſtantly directs the formation of their bodies. The tranſition is natural and eaſy. God is not leſs careful of *living beings*, than of *vegetable things*. I ſee it now! This is that *remarkable connexion*, which you hinted before to be between the vegetable and animal kingdoms, gently guiding our mind in the continuation of the *ſcale:* the ſteps are ſoft, indeed, and beautiful in this view! The *lower animals* were not immediately to be abandoned to the guidance of their own powers. The tranſition from plants *(mere vegetating matter)* to free and ſelf-directed living beings, had been violent, and indeed forced. O! I am charmed with the thought! How unnatural would the contrary ſuppoſition appear, to a mind not miſled by prejudices! How impoſſible, that ſuch little inſects, ſuch microſcopical animalcules, could have provided for their own lives, for the continuation of the ſpecies, had not the wiſdom of the *Creator* ſupplied their want of power and knowledge! This is that other *limit* you ſpoke of, which bounds

ſenſitive perfection on the one ſide, as reaſon does on the other.

P. This is that principle of INSTINCT, Matho, which we talk ſo much about, without being aware how *real* it is, or how widely it extends among the tribes of animals, not excepting man himſelf.

M. I was going to obſerve how indulgent and kind the Creator is: for from the inſtance of *ſucking* and *ſpontaneous motion* I ſee, that were it not for his ſupplying the want of knowledge by his early direction, no ſpecies of animals, not even man, could get over the firſt difficulties of life, but muſt inſtantly give up their new-gotten breath, under an inability and ignorance what to do to preſerve it.

P. The change in truth, as you obſerved juſt now in the other caſe, would be too ſudden and violent, to abandon an animal newly excluded the womb, which was but the moment before in the circumſtances of mere vegetation and *plant-exiſtence*; to abandon it, I ſay, all at once, to its own care and proviſion, with no more experience and power than it brought from the dark cell of the womb with it.

M. From this I ſee, that what we call *inſtinct* in animals is the conſtant and immediate direction of them, by the ſame divine power and wiſdom, which brings forward and guides every plant of the field, to its ſpecific perfection. It is this pleaſing conſideration which we conceal from ourſelves, by aſcribing all theſe miracles of power and goodneſs to *nature*.

P. Nature, Matho, is the deity of the *atheiſt*, the knowledge of the *ignorant*, and the refuge of *a ſlothful mind*, in which all abſurdities are conſiſt-

ent.

ent. Nature, as an *universal surd cause*, supersedes farther enquiry; and as a *mere non-entity*, it requires of us neither fear nor reverence.

M. I shall be upon my guard for the future, to have a consistent meaning in view, when I use the word: but it is a misfortune that the common use of language has almost consecrated a *term* that misguides us; whereas *the Author of nature* is a manner of expression, which carries with it light and information to the mind.

LXXXIV. *P.* To return, these lower animals are constantly guided by this principle of *instinct*, which never forsakes them: this we may conclude from considering that experience makes them not more perfect in their *buildings*, *manufactures*, *provisions*, than they were at first.

M. And from this also I conceive, that many species of them live but for one season, and do the same works but once.

P. And even in those, Matho, which survive for several years, we never find any improvement. Not only in the works of the *bee* or *spider* we perceive no difference between the performance of the young and the old; but we find the same equality of architecture in the nest of *birds*, whether they have built for the first time or oftener. Which shews us that experience is of no use to them, and that they still act under the direction of the first principle.——In rising through the scale of animals, we may observe that they begin gradually to act in many cases by the direction of sense; but wherever that would fail to guide them, *instinct* comes in to their relief. Hence it is that they know their *enemies* at any time, though they have never seen them before;

and

and their *natural weapons* for defence, though they never had occaſion to uſe them before. The females through all the ſpecies are as *perfect mothers*, and as knowing in rearing their young for the firſt time, as ever after. The cowardly then become reſolute, and the ſimple full of ſtratagem: afterward they ſink into their natural ſtupidity again. Whence this *temporary* courage and ſubtlety? This ſhews that *inſtinct* never forſakes the moſt perfect of the brute ſpecies, when the point concerns *ſelf-defence*, or the *propagation of the kind*.——It hath been excellently obſerved on this head, that reaſon is full of variety, and therefore is ſtill ſupplanting one contrivance with another. Hence the diverſity of arts, cuſtoms, manners, and of language itſelf, in different countries, and ſucceſſive ages. It is not ſo among the moſt perfect ſpecies of brutes; they have the ſame unvaried talents, ſagacity, and ſpecific endowments, in all countries, and through all ages. This at once ſhews the *limitation* of their nature (which we ſpoke of before) and that theſe arts and permanent policies are not of their own deviſing. Take any of theſe animals from the *dam* when young, and bring it up ſeparately from the reſt of its ſpecies; notwithſtanding this, you will ſee it grow up as perfect in all the arts and behaviour of that ſpecies, as if it had been bred among them. On the other hand, imagine that ſome of thoſe ſtories we have heard related were true; and that one of our ſpecies was ſuckled, and brought up by the wild beaſts in the woods; and then conſider whether ſuch a creature would naturally fall into the manners and behaviour of mankind.

M. It is not to be ſuppoſed; ſuch a creature would be a *mute monſter*, agreeing with no ſpecies

cies of animals in the creation. I am quite ſatisfied of the force of *improvement* upon human nature, and that it has no force at all upon the brutes, which are made perfect at one ſtroke: hence I perceive that the faculties by which men, and inferior animals, become perfect in their ſeveral ſpecies, differ not only in *degree*, but in *kind*, as you obſerved. I could aſk you many queſtions concerning the origin of language, which I ſee is not natural to mankind, though moſt other creatures have ſome natural cry, which I ſuppoſe has been peculiar to the ſpecies from the beginning of the world: but, without interrupting you, ſhall obſerve, that I have often known a *puppy* grow up in a family, where it ſaw none of its own kind, and yet become as perfect in the arts and genius of that ſpecies, as if it had been educated in the kennel.

P. The brute mind is certainly leſs active than the human; the great ſpring of action in them is their being ſtimulated by ſome bodily appetite: now that a leſs active being ſhould ſo readily jump into all the arts and manners peculiar to their ſeveral tribes, and be utterly incapable of any other; and that man, with more activity of ſoul, ſhould require ſo much time to acquire the perfections of his nature; concludes ſomething more than mankind will allow themſelves to reflect upon.

M. You have brought me entirely over to your ſide. As this argument is equally applicable to the moſt perfect, as well as the leaſt perfect animals, it convinces me that theſe *unſtudied arts*, theſe *extemporary endowments*, for which we ſo much admire them, are none of their own acquiſition, as men's are, but come from a higher origin.

P. It

P. It ſeems to me equally to cut off the pretenſions of the higheſt and loweſt ſpecies to the power of reaſoning. Senſitive perfection, indeed, riſes by various degrees, which always brings their actions nearer an imitation of ours: their ſenſes aid each other in a manner we can never be judges of. No man would allow that colours might be diſtinguiſhed by the touch, if ſome inſtances did not ſhew it poſſible. From this acuteneſs of ſenſe it is, that many animals prognoſticate the changes of weather, which we cannot foreſee. You remember the paſſage,

——*Nunquam imprudentibus imber*——

A great ſource of our miſtakes about brutes ſeems to be, that when we conſider ſome of their actions, and the operations of our own minds in like circumſtances, without farther examination of their natures, or taking in the whole tenor of their actions, we aſcribe to them, from theſe particular, equivocal appearances, all the workings of the human mind.

M. I am verily perſuaded this is often the caſe. We early contract a liking to ſome particular animal, or ſpecies, which makes us partial in their favour; and then we ſet up for *rational brutes* all our lives after, without examining the point farther.

P. This is the firſt notion we naturally fall in with, and it rarely comes under ſuch a ſevere review, as moſt of our other early prejudices. But it is time to leave a ſubject, which you will hear diſcuſſed in every company, according to people's humour or inclination.

LXXXV. *M.* Pray, before we leave it, tell me, what that power of the ſoul is, in which reaſon chiefly conſiſts, and which the brutes have not?

P. We have not time to go to the bottom of that ſubject: however, I ſhall tell you in general what my thoughts are about it. Brutes have certainly the ſame power of ſpontaneous motion, as we men have; and ſome of them a more early and abſolute command in moving their bodies: moſt ſpecies alſo have their ſenſes far more acute than man, as was obſerved juſt now. And it was but reaſonable, that creatures, which want a higher power of the ſoul, ſhould have the ſenſitive nature in greater perfection. If then they had the ſame command over the perceptions of the mind that man has, they would be, I think, equally rational. For if we conſider your inſtance of *a puppy brought up in a family*, without ſeeing any of its own ſpecies, it has certainly the ſame original perceptions, as the infant with whom it lives familiarly: and if it could make the ſame uſe of the ſame original ideas, or work the ſame way with them, it would improve equally, and at length become as perfect a *reaſoner* as the child.

M. I perceive the truth of all this as you go along.

P. Then it could be ſhewed, I preſume, with exactneſs and preciſion of argument, that the power of calling back to view, and detaining under conſideration, the paſt perceptions of the mind, is that alone from which all the rational operations of the human ſoul are derived.

M. Do you think that ſuch a variety of operations can ſpring from ſo ſimple a power?

P. This appears to me a right ſymptom that the thing is really ſo. Nature (to ſpeak in the common

common way) that is, the wiſdom of the Deity, is frugal in the means, and fertile in effects. By the help of this power alone, we compare our original ideas, compound them, divide them, and abſtract from them; forming at firſt with difficulty general notions, and from theſe again others ſtill more abſtract; and, in a word, perform all thoſe operations, which belong to ratiocination. It is but the ſame power variouſly exerted, to which men have given the names of various operations. For in ſeeing the agreement or diſagreement of our ideas, or their ſeveral relations to each other, after they are carefully formed, and clearly perceived, we are as neceſſary, or paſſive, as in ſeeing the agreement or diverſity of two objects when preſented to the eye. And you may obſerve in all the arts that men learn, the various application of the ſame power begets a great variety of appearances in the practice.

M. I begin almoſt to be perſuaded of this, when I conſider that the power only of moving the hand is that by which all mechanical arts are acquired and practiſed; though this power receives various turns, as the hand is habituated to different tools or inſtruments: and if the hand is any way diſabled, the exerciſe of the art is loſt.

P. No ſimile hits in all reſpects, Matho; but yours is ſo far juſt, that if we ſuppoſe the power of calling back paſt perceptions into the mind entirely loſt, though the man ſhould ſtill be a *percipient being*, he could no more reaſon, or reflect on what did not immediately ſtrike his eye, than he could read a book in the dark, or ſee objects through a ſtone wall.

M. Thus far is very plain.

P. Conſider alſo this circumſtance. If we had not

not the power of calling back our paſt perceptions at pleaſure; but if, inſtead of that, they were obtruded upon us, or brought into our view at the diſcretion of ſome other being (as often happens in our dreams) we could never reaſon conſiſtently, but ſhould live under one continued deception.

M. I believe I muſt come into your notion, that this power is really the foundation of reaſoning; ſince if it be taken away, or reſtored, the faculty of reaſoning is at the ſame time loſt, or recovered; and in proportion as it is diſturbed, our reaſoning becomes inconſiſtent; as is often the caſe in ſleep, and diſorders of the head.

P. If then we conſider, in the laſt place, that the mind of brutes is calm and ſtill, unleſs when ſome call from ſenſe prompts them to action, it ſeems to follow, that this power of calling back their paſt perceptions to view, is the power they are not endued with; in conſequence of which they have nothing to guide them, when taken out of the train of *ſenſe* and *inſtinct*, whence they muſt act abſurdly in all ſuch caſes.

M. All this is extremely reaſonable; but there is ſtill one thing occurs to me, which looks like an objection.

P. What is it?

M. Brutes ſometimes ſeem to act from the ſame principle, and in the ſame manner, as rational creatures do: thus an animal bereaved of its young, or of its mate, is hurried on with rage, or ſunk in grief.

P. The inferior creatures, Matho, are tortured with more violent paſſions than men; which is by no means a mark of their being rational, as ſome imagine, but rather of their being irrational.

Paſſion

Paſſion is purely an *animal affection*, and maintained in the mind, not by a command over the paſt perceptions, but by a want of command over them; or by the ſame perception remaining ſtill in view. The object of *grief*, *jealouſy*, or *revenge*, ſits cloſe on the brute mind; and by that alone it is hurried on, without relief from the power of calling in other ideas to be at the ſame time conſidered. It is thus they fight and tear each other, with irreconcileable rage, and often without any apparent provocation. We may know ſomething of this from our own experience: the expreſſions, *Ira furor brevis eſt*——*Impedit ira animum*—— have a more philoſophical meaning than we are aware of. Could we examine our paſt perceptions coolly while in paſſion, as at other times, we ſhould rarely be under theſe brutal affections. So that I would take the liberty to correct what you call an objection, and, inſtead of ſaying that brutes act from the ſame principle, and in the ſame manner as rational creatures; ſay, rational creatures often act from the ſame principle, and in the ſame manner as brute beaſts.

M. I find what I took for an objection, rather confirms what you advanced.——With reſpect to that conſtant *ſtillneſs* and *ſilence* which you ſay reigns in the brute mind, except when the calls from ſenſe ſolicit it, I have obſerved, I think, that ſome ſpecies of brutes, thoſe particularly that feed on vegetables, ſleep leſs than man: their whole buſineſs ſeems to be food and reſt. Now I have often wondered what could be the object of their thoughts, while they lie for ſeveral hours together on the ground: and I begin to fancy, if their minds were buſy all the while, their bodies would not have ſo much eaſe; that they would

be put on ſome action, or give ſome indication of what paſſed then in their thoughts.

P. This calmneſs and inactivity of the brute mind ſeems to be every way wiſely ordered: for to what purpoſe ſhould creatures have their minds occupied, whoſe nature requires nothing, which they are not in poſſeſſion of? And then, were they to reflect ever ſo little, how terrible would they be to man! It muſt be conſtant war, without quarter on either ſide. Did they know their own advantage, who durſt appear in the fields, or perhaps be ſafe in houſes? The *laborious ox*, and the *ſerviceable horſe*, would be our moſt dreadful enemies. The moſt tractable creatures would rebel, and few are ſo weak that might not annoy us. It would make all the odds in the world to the life of man, to want their aſſiſtance as brutes, and to feel their enmity as rational creatures. Conſider the conſequences of this at your leiſure, with reſpect to our carriages, travelling, tillage. They could live eaſily without us; eſpecially when furniſhed with rational faculties. Men will needs have brutes to be rational, without conſidering what a miſery it would be to us, if they were. If they reflected but ever ſo little, they would never bear the unequal conditions they muſt then labour under. Would they ſubmit their back to the blows, and their throats to the knife? What goodneſs is it then, that creatures ſo much ſtronger than man ſhould nevertheleſs be ſubjected to the ſuperior power of his mind!

LXXXVI. *M.* Theſe reflections are quite new to me: I ſee with ſurprize the terrible diſorder that muſt enſue in the animal world, on the ſuppoſition that brutes were rational. I have

only one more queſtion to trouble you with on this head.

P. I am glad to hear that; pray propoſe it.

M. Does the advantageous ſtructure of the human body contribute nothing to the perfection of the rational ſoul? Or would not a brute ſoul be rational if in a human body?

P. You obſerved frequently and juſtly, at our laſt meeting, that a mere figure, or mere order of parts, can teach a creature nothing. Were you or I turned into the figure of a ſwallow, as the poets ſay Progne was, we ſhould know no more of building a ſwallow's neſt (which, though clumſy in appearance, is juſtly admired as a notable piece of architecture) than if we were turned to the ſhape of a four-footed beaſt. We could do nothing without being guided by the ſame principle of inſtinct, as well as having the ſame figure. The lark, and ſeveral other ſmall birds, ſeem as much cut out for ſuch a piece of work, as the ſwallow: yet every one of theſe have a different art of building, and quite different inſtincts. Animals differ more in their inſtincts and genius, than in the ſhape and figure of their bodies: conſider a *hare* and a *rabbit*; or a *rat* and a *mole*; they have quite different inſtincts, and ſcarce live in the ſame element. Many ſuch inſtances might be given in birds and fiſhes. This could not be, if the various ſtructure of the body endued creatures with various talents. Have you reflected on the abſurdity contained in your queſtion? *The Deity forms the body, a ſyſtem of dead matter; and this ſyſtem of dead matter forms the ſoul!* The origin of this unaccountable prejudice is, becauſe the Creator hath ſo wonderfully adapted the ſtructure of the body to the capacities and powers of

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the living part. Hence we infer, that the ſoul owes its capacities and powers to the ſtructure of the body. Pray call to mind again the inertia of matter: I thought there had been no occaſion for renewing the conſideration of that ſubject.—— The *ſpider*, it is true, could not handle her delicate threads ſo nicely, without her exquiſite fine fingers: but thoſe fingers do not teach her to diſpoſe her threads, or how to accompliſh the deſign of her web. The club-ſhape of the *bee* is nevertheleſs excellently fitted to the forming her hexagonal cell: but this ſhape doth not ſhew her either the property of that figure, or how to obſerve the proportion in practice. The ſhort ſtrong legs of the *mole* are ſkilfully deſigned for her working under ground; but they might for all that remain uſeleſs, unleſs ſhe were prompted with the art of employing them. And ſo in other caſes. The parts of the body, therefore, ſerve only as inſtruments to anſwer the ſeveral powers and inſtincts of the immaterial being: but ſurely they are neither the *powers* that move themſelves, nor do they teach the art whereby they are employed. We ſaw before, that the power of the Deity muſt intervene to perform the mechanical part of ſpontaneous motion, and relieve the ſoul: and as to the method by which this is contrived, it remains an impenetrable ſecret. After this let a ſober man ſuppoſe, if he can, that the different ſtructure of the body makes one creature rational, and endues another with inſtinct.

M. Though all this be now very plain from what you ſaid before, I ſhould have been at a loſs in making the application; and am pleaſed that I propoſed my unſkilful queſtion. As the brute body could not give any inſtinct to the human ſoul;

ſo contrarily; I ſee now that the human body could not make the brute ſoul rational.

P. Moſt certainly it could not. There is nothing ſo unphiloſophical, and abſurd, as thoſe idle ſtories of changes of ſhapes, and metamorphoſes, with which the heads of boys are ſtuffed. Were a brute creature transformed into a human ſhape, it would be nothing more than a *breathing* or *ſenſitive log*, without ſo much as the power of ſpontaneous motion in ſuch a new body. This firſt ſtep (as was obſerved) would require the interpoſition of the Deity. And then conſider the human ſoul itſelf, by what various degrees of improvement it arrives at the perfection of its nature. After that tell me, if you think a brute ſoul could be converted into a rational being, merely by ſhifting habitations?——It is certain, that the firſt of our ſpecies were made rational, and endued with knowledge, without their own application; that is, by the immediate power of the Deity. All the philoſophers on earth will never account for the origination of mankind otherwiſe. And in the ſame manner alſo they were prompted with the firſt uſe of language. Now to imagine that a frame of dead matter ſhould have the ſame effect, as the divine power, is, to ſay no more, ſtrange inattention.

M. I am glad you have given me this hint concerning the origin of language. Young people help to deceive themſelves by their own credulity. When I read that piſmires were metamorphoſed into the *myrmidons*, I imagined they ſpoke the Greek language of courſe: as if language was a neceſſary conſequence of having a human figure.

P. Leaving fable, Matho, we may obſerve,

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if the frame of the human body could not give the ſoul the power of moving itſelf, without the immediate help of the Deity, it could much leſs endue the ſoul with the power of reaſoning. The body of man, indeed, has a more curious mechaniſm, a more complicated apparatus, and particularly in the brain, than the body of any other animal; as *anatomiſts* have obſerved, and as was but juſt and neceſſary, to ſerve for more various purpoſes: but all this apparatus is only the inſtrument for executing, not the power that executes. A more complicated machinery requires more power to work, or employ it, than a ſimpler ſyſtem; but can as little impart any power, as unwrought matter itſelf.

M. This I underſtand; and from this I conceive it will follow, that a diſorder of the mechaniſm in the body, would impede the exerciſe of the powers of the ſoul: but the beſt order could beſtow no power upon it.

P. It is directly ſo. You obſerved excellently well before, that a *loom* could never teach one the art of weaving; though one who underſtood the art of weaving might employ it to that purpoſe. And the argument is the ſame wherever matter or mechaniſm is employed. And after all, pray reflect, Matho, what abſurd and inconſiſtent ſuppoſitions thoſe are, which we borrow from the *poets*; *That a brute ſoul ſhould animate the human body, or a rational ſoul the body of a brute.* By whoſe power could this be effected? If by the Creator's alone, why ſhould we ſuppoſe him to act contrary to the natures of things by him eſtabliſhed? Or why ſtudy to draw an argument from his power for equalling beings, which the ſame power has made different? This is taking an ar-

gument from the wrong ſide to ſuppoſe the power of the Deity to counteract his wiſdom. Since the uniting of the ſoul to the body is his immediate work, there can be no miſ-joining of ſouls to bodies. We firſt ſuppoſe that *chance* might have the ordering of this affair, and then enquire how things would be, if diſpoſed otherwiſe than the Deity has done: which is notably fooliſh. It is as if we ſhould aſk, what kind of a flower the *tulip* would be, if it ſprung from the ſeed of a *melon?* Or what taſte an *onion* would have, if it grew on a *fig-tree?*

M. You have fully opened to me the whole impertinence of my queſtion, and the ignorance of ſuch ſuppoſitions. I hope I ſhall think more correctly with regard to theſe matters for the future.

P. We ought to reflect with pleaſure, Matho, that the power of the Creator is immediately concerned in the natures of theſe irrational creatures: this is doing juſtice to them; and it aſſures us that he will not, cannot neglect rational beings.

LXXXVII. *M.* After this ſhort view of the works of nature, pray reſume a little, before I leave you, a ſubject you juſt touched upon ſome time ago, concerning the nature of the Deity, and the neceſſity of his exiſtence.

P. I thought Matho had been a man of his word.

M. Come, Philon, you muſt not deny me: you do not uſe to do a good office by halves.

P. It is not an eaſy thing to ſpeak of the Deity abſtractedly, and in his own nature, which is ſo much above our comprehenſion: it is both more *intelligible*, and more delightful, to ſpeak of him

as the cauſe of all other things that exiſt. In thoſe effects we ſee his perfections of power, knowledge, and goodneſs, diſplayed to us in the moſt obvious manner; and thence come to the knowledge of him, as he is the Creator of all things. This, as we obſerved before, is a comfortable relation, between the Deity and us.

M. But pray ſhew me how the neceſſity of the Deity's exiſtence appears?

P. *Power* and *knowledge*, you know, are that only which is neceſſary in the nature of things; for this obvious reaſon, becauſe if power and knowledge did not neceſſarily exiſt, they could not be produced by a cauſe without power and knowledge; that is, by an *ignorant* and *impotent cauſe*. Which is the ſame as ſaying, if power and knowledge were not neceſſary, they muſt be abſolutely impoſſible and contradictory. Thus far you ſee?

M. Perfectly well.

P. Then, for the ſame reaſon that power and knowledge are at all neceſſary, infinite power and knowledge are neceſſary: for things of a contrary nature could not limit them; or rather, there was nothing of a contrary nature to limit them. Since impotence and ignorance are mere negations.

M. Thus we find infinite power and knowledge neceſſary.

P. Next, it is the nature of infinite power and infinite knowledge to be united, or to belong to the ſame being. Things of a contrary nature, or mere negations, could not ſeparate them. Nothing could oppoſe infinite power, or ſeparate knowledge from it, except impotence, or want of power, which is no cauſe: nor any thing ſeparate power from infinite knowledge, except

ignorance, which is nothing poſitive. And it is not the nature of infinite power to divide itſelf from knowledge, nor of infinite knowledge to divide itſelf from power: the firſt would be then *infinite fury*, and the ſecond *infinite folly*.

M. Moſt certainly.

P. Then, from a plenitude of power and knowledge, you yourſelf inferred the neceſſity of *goodneſs* and *juſtice:* becauſe a being, poſſeſſed of all power and all knowledge, could neither have *malice* nor *envy*; nor therefore be tyrannical, nor unjuſt; but rather infinitely good, and infinitely juſt. This is a neceſſary reſult from boundleſs power and knowledge.

M. This too I remember very well.

P. Now, ſince it is the nature of theſe four perfections to belong to the ſame being, and ſince there was nothing of a contrary nature to ſeparate them; or ſince their nature is all that *was*, or *is neceſſary:* that they ſhould be ſeparated from each other, or divided among more beings, is a thought ſo much without foundation, that when we form our notions truly, and according to reaſon, it will not be in our power to conceive the poſſibility of it. Hence the *unity* of the *Deity* ſo little wants a proof or demonſtration, that we muſt ſee it neceſſarily and intuitively, when we fall into the right train of thought.

M. You have reſumed the ſubject juſt in the very manner I wanted to hear it: this will ſtick with me better, becauſe it is a ſhort connected account.——From this I ſee that it is the moſt grievous abſurdity, and a contradiction to nature, to ſuppoſe the *non-exiſtence* of the Deity. If the Deity did not exiſt, nothing at all could ever have exiſted. There muſt then have been an in-

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finite and universal non-existence, *an infinite, an eternal,* and *necessary nothing!* What a monstrous absurdity is this! *Being* and *perfection* must then have been necessarily impossible! What poor reasoners the atheists are, who do not see the necessary nature of *power* and *knowledge*, from this alternative, That these must either be absolutely necessary, or utterly impossible in nature!—— An *infinite*, an *eternal*, a *necessary nothing!* These are terrible contradictions!——Infinite, eternal, and necessary, must belong to something positive. Hence I see that *being* and *perfection* must be *infinite* and *necessary:* or this necessity concludes for plenitude and infinity of being and perfection, as much as for being and perfection at all.

P. You have entered deep into the thought, Matho.

M. This subject was difficult to me the first Time we touched upon it: but now I am saying nothing but what I have a clear and firm notion of.

P. Allow me then to ask you a question or two.

M. With all my heart.

P. Does this necessity hold as well to eternity as from eternity? For some people doubt of this.

M. It is a necessity of nature, which can never wear out, nor hath it respect to time. To suppose that this necessity could ever cease, is to suppose the *necessity* of being and perfection a *possibility* only of being and perfection! It is to suppose that necessity of existence might at length become a necessity of non-existence! It is to suppose that *nothing* might some time or other be possessed of the properties of *infinite* and *necessary!* If *nothing* may have this reality of nature, *truth* is at an end,

and *reaſon* antiquated! Laſtly, thoſe people forget, that this is the neceſſity of infinity of power and knowledge. What could prevail againſt theſe?

P. You point rightly to the monſtrous conſequences of a contrary ſuppoſition. Tell me next, Doth the exiſtence of the Deity depend upon his own *will* or *power?*

M. To ſuppoſe the Deity exiſted, becauſe he willed it, or had power to give himſelf exiſtence, is to ſuppoſe him once not to have exiſted, and at the ſame time to have had a will whereby he choſe to exiſt, or power to cauſe himſelf to exiſt. Theſe are ill-coupled and inconſiſtent notions in the brain of man. As was ſaid before, to perform or reconcile any contradiction, is not the object of real power or knowledge, and leaſt of all to perform or reconcile this ſhocking repugnancy. To ſuppoſe the perfections of the Deity to depend upon his power, or will, is only ſetting one perfection of his nature in oppoſition to another, either ignorantly or perverſely.

P. This is a notable inſtance of contradiction, which we may leave the *ſceptics* to doubt about: and ſince the performance of any contradiction ſuppoſes the power of the Deity to give his knowledge the lie, we may obſerve, as we go on, *how firm the baſis of human knowledge is.* Let me only aſk you farther, ſince the exiſtence and nature of the Deity alone is neceſſary, whence have other things their nature and exiſtence?

M. There being no ſource from which any thing elſe can be derived, all other things muſt be his effects: or they muſt have been created by his power, and have derived their natures (or the properties of their being) from his knowledge.

And

And now, Philon, I ſee that the Deity muſt be the *creator of all things*, even by this method. For, as I underſtood before, by conſidering the nature of matter, that it was the effect of his power; ſo I perceive now, by conſidering his nature, that matter, and all things beſides (I mean *immaterial living beings*) are the effect of the ſame power.

P. We may indeed come to the knowledge of the ſame truth, either by beginning with the *effects*, and mounting to the *cauſe*; or by beginning at the *cauſe*, and deſcending to the *effects*. Both methods are good in conjunction, and ſerve to illuſtrate each other: but this laſt method does not convey ſuch a practical conviction to the heart; and it requires a mind perfectly ſubjected to the determination of reaſon: though it may ſometimes be neceſſary to ſilence a metaphyſical *adverſary*, who may run up his objections into abſtract ſpeculations. For then, as was obſerved before, we can thus ſhew, that the reaſon for the exiſtence of the Deity does not depend on the exiſtence of the material world.

M. But, with all ſubmiſſion, I cannot help thinking, Philon, that the mind of man often runs into theſe abſtract ſpeculations by itſelf, and without being forced upon them by oppoſition. We naturally indulge ſuch thoughts at times, and the reveries of young minds are nearly allied to the reſearches of philoſophers. I have often thought with myſelf what muſt have happened if nothing had exiſted from eternity? Or why all things might not again ceaſe to be? Let me throw out of exiſtence whatever I would, I found *eternity* neceſſarily remaining, and *ſpace* too; but had not compaſs of thought enough to reflect on

the reaſon that ſhews *power* and *knowledge* the firſt things neceſſary. Now in ſuch caſes it is of uſe to have ſome firm principle to reaſon from, or return to, when one finds one's ſelf loſt in the enquiry. And upon this account pardon me, if I think that it is proper to enter a young friend on the conſideration of the neceſſity of exiſtence, as ſoon as it becomes liable to fall into theſe reveries.

P. I dare not diſpute your experience, Matho: but, ſince you think theſe notions ſo eaſy to young minds, pray make the trial among your companions, ſince you ſay you diſcourſe our ſubjects over again with them.

M. I ſhall not fail to try the experiment, and report the ſucceſs.——But,

LXXXVIII. Something occurs here, which I cannot well reconcile to what has been ſaid.

P. What is that?

M. If nothing beſides the Deity himſelf be thus neceſſary and immutable, how is it that we find *truth* equally neceſſary, and the ſame from eternity to eternity? No power can change the nature of truth, or, as was obſerved juſt now, make a contradiction true.

P. Nothing, Matho, except the Deity himſelf, or what belongs intimately to his nature, can be neceſſary. And hence it is, namely, becauſe the nature of truth is neceſſary and eternal, that an *eternal intelligence*, or the *divine intellect*, is diſcoverable by us in a very ſingular manner, and wonderfully proper to the nature of the thing.

M. Pray ſhew me how that diſcovery is made.

P. Eternal truths have no connexion with the exiſtence of created things, and can neither be created

created nor periſh; but being neceſſarily and unchangeably true, were always known in the *divine intellect*, where they exiſt immutably (if the expreſſion may be proper) which *intellect* therefore they diſcover to us immediately.

M. As this is quite new to me, pleaſe to explain it more at large.

P. Have you never heard that in the *abſtract ſciences*, new truths and properties of things, ſuch, to wit, as were not known to mankind before, have been diſcovered?

M. Often; and thoſe deſervedly praiſed by whoſe induſtry thoſe truths were brought to light; at the head of whom, I ſuppoſe, from what you have ſaid, the Great Newton deſerves to be placed.

P. You have reaſon to ſay ſo.—But did thoſe authors make ſuch truths originally, or frame and mould them according to their pleaſure?

M. Surely they did not; for then the truths could not have been ſaid to be diſcovered, or found out, but truths newly made or contrived. When any thing is diſcovered, it muſt have been the ſame thing before it was diſcovered, as after. When a man diſcovers a *mine* in his ground, it would be abſurd to ſay, *he contrived* or *made the mine.*

P. Beſides, Matho, if it were poſſible to *coin* or *ſtamp* new truths, according to every man's fancy, what work ſhould we have? What confuſion, and ruin of all truth? You may imagine the conſequences of this yourſelf. Every man would raiſe a ſyſtem of ſcience, to ſupport his party, or advance his intereſt; and another would confute it by contrary truths, to maintain his ſide of the queſtion. Where would this end among

jarring

jarring humours and contrary factions? Truth would fight againſt truth, and nothing could be true.

M. Ah! ſpeak no more of it; the confuſion would be inexpreſſible! Nothing is more neceſſary than *that truth ſhould be neceſſary, and unyielding*; that men of honeſt intentions may have a certain ſtandard to be directed by, and deſigning men ſomething to condemn themſelves in their own breaſts.

P. If then the nature of truth be thus eternal and unchangeable, from what ſhall we derive it? Conſider that queſtion firſt.—Then, Does not the Deity, think you, know all truths?—Could his knowledge be infinite if he did not?—Can there be any knowledge in a created intellect that he does not know?

M. That cannot be ſuppoſed, without an impious abſurdity.

P. Could he be beholden to any thing elſe, do you think, for the perfection of his intellect? Or can truth have a ſeparate nature, to and from which he is forced to apply and learn? We ſaw that his knowledge is neceſſarily infinite. Can truth then, eternal and neceſſary truth, have a ſeparate nature of its own, independent of this neceſſary infinity of knowledge?——Where will you place this independent nature of truth?—In emptineſs! inert matter! or a negation of perfection! For the nature of the Deity comprehends, exhauſts every perfection; leaves out nothing except imperfection, impotence, and ignorance.

M. Do not multiply your queſtions ſo faſt. I ſee that the neceſſary infinity of knowledge, and the neceſſary unchangeable nature of truth, muſt coincide.

P. Let

P. Let a man ſhew me two ſeparate neceſſary natures; one to be the fountain of truth, and the other the origin of knowledge abſtracted from truth.

M. You make the contradiction monſtrous; and have fully ſatisfied me of this truth, *That all truth was eternally in, and draws its nature from, the divine intellect.* Aſk me but one queſtion at once, and try if I can give you diſtinct anſwers.

P. Tell me then, When did thoſe truths, the diſcovery of which you have heard ſo much celebrated, begin to be truths?

M. They never had a beginning, but were always and neceſſarily true, before they were underſtood by us; and would be always equally true, though no created intellect underſtood them. The truths yet undiſcovered are equally certain, and equally known to an *infinite intellect*, as when they ſhall be perceived by men. The nature of truth, or the certainty of it, does not depend on the accident of being known by more, or fewer. It is abſolute, and above all ſuch conditions.

P. Has truth a nature?

M. What is neceſſary and immutable, muſt have a neceſſary and immutable nature.

P. Whence doth truth derive this neceſſary and immutable nature?

M. From the divine intellect, where it was always known, and always exiſted. Every piece of real knowledge, every demonſtrative truth we come to ſee, is a part (ſo to ſpeak) of that knowledge which was eternally in the *divine mind.*

P. Hath truth no ſeparate ſubſiſtence by itſelf?

M. It hath not; nor can it have a ſubſiſtence in any thing *ſurd*, and *unintelligent.*

P. What is truth then?

M. It

M. It is *knowledge* or *ſcience* in the intellect of ſome being. Truth exiſting in no intellect, is as repugnant as knowledge exiſting in no intellect, or power belonging to no being. Truth (as I underſtand from what you ſaid juſt now) is the connexion or agreement of ideas, and ideas cannot be out of a mind. Eternal truths, therefore, muſt always have exiſted in an *eternal mind*; which they thus diſcover to us, in a method, indeed, as you obſerved, moſt proper to the nature of the thing.

LXXXIX. And now, Philon, I have not received a more ſenſible pleaſure from any thing you have yet ſhewed me, than from this new diſcovery of the Deity. I ſee as much the exiſtence of an *eternal mind*, of an *infinite intelligence*, as I ſee that truth was before I was born, or before the firſt man was created. This is a demonſtration of the Deity, as an *infinitely knowing being*, which the mind of man draws from nothing from without, from nothing in the viſible frame of nature, but only from its inward perception of truth. The method from the *human* to the *divine mind* connects the ſoul of man immediately with the Deity. Theſe eternal truths are to our intellectual nature, what the viſible wonders in the heavens or earth are to the eyes. What a pleaſure is it to reflect that our real knowledge is a part of the knowledge in the divine intellect!

P. Conſider from this then, Matho, how blame-worthy thoſe men are, who have endeavoured to perſuade the world, that there is not a *governing mind*, a *ſupreme intelligence*, in nature; who acknowledge only the blind force of inert matter in all the wonders of wiſdom and knowledge

ledge we obſerve; and, to veil their perverſeneſs, ſpeak of *dame nature* as a deity, which, by an equivocal ſound, takes off the abſurdity to the ear.

M. Since the power of a dead ſubſtance is a contradiction, this is throwing off both *infinite power* and a *governing mind* at once. It would be a wretched ſovereignty, if (as thoſe people ſeem to intend) man was the ſupreme intelligent being in the univerſe! But what madneſs poſſeſſes miſerable mortals, that they ſhould endeavour to perſuade their fellow-creatures, that this world is the off-ſpring of chance, without a being of infinite perfections to govern the whole! Can it be againſt any one's intereſt, if infinite power, directed by infinite wiſdom and goodneſs, ſhould rule the univerſe and the affairs of men! Is it not rather a proſpect full of comfort and ſecurity, to find the Deity at the head of nature?

P. Eſpecially if we conſider, that without this proſpect there could be no pleaſure nor tranquillity in the life of man. A confirming ourſelves in ſteady deſpair would then be our only hope, and the loſs of being our only relief from conſtant terrors: for who could be ſecure amidſt the ſtorms of unguided matter, and exiſting only at the diſcretion of chance? Men have thrown life away, when they imagined it contained more miſery than comfort; which as they could only have imagined on this ſuppoſition, ſo on this ſuppoſition no man could imagine otherwiſe.

M. But with what view do they endeavour to bring mankind under ſuch a wretched and comfortleſs ſtate?

P. They were reſolved to acquire fame and repute to themſelves, let the ſtate of mankind be as wretched as it pleaſed.

M. To

M. To acquire fame by denying a Deity!

P. When a man's firſt paſſion, Matho, is the deſire of being ſpoke of, and when he deſpairs of being diſtinguiſhed for any laudable attempt, this he lays hold of as a compendious way of attaining his end. The generality of mankind believe and revere a Deity; and only a *fine genius*, forſooth, can deſpiſe both a Deity and mankind.

M. Deteſtable fury!

P. If it were poſſible, Matho, that ever any man ſince the beginning of the world had denied a Deity from the conviction of his own arguments, I ſhould not aſcribe their impiety to this paſſion.—Yet they pretend, for decency's ſake, by denying a Deity, to ſupport the cauſe of truth.

M. That is full as ridiculous as the other is impious! What have they to do with truth, after denying the *infinite intelligence*, the only ſource whence it can be derived? Pray, in what do they place the nature of their truth? In the inconſtancy of chance? Or the inactivity of matter? Or in the infinite abyſs of emptineſs?

P. It would ſurprize you more to tell you, that ſome of them have pretended the great advantages of atheiſm to mankind; but it is needleſs, if not ridiculous, to look for conſiſtency in their ſchemes: leaving them therefore to the contempt they merit, tell me,

XC. Since the Deity depends on no ſuperior cauſe, or ſince his exiſtence and perfections are neceſſary, can any thing be wanting to him which can belong to a perfect and happy nature?

M. This queſtion has been anſwered in effect, I think, from many things that have been ſaid already. A neceſſity of perfection implies infinite perfection,

perfection, and infinite perfection infinite happineſs. It was thus we ſaw his infinite goodneſs, becauſe, by a plenitude of perfection, he is infinitely raiſed above all wants.

P. From this it will follow, that the happineſs of the Deity and *that* of his creatures are of a different nature: *our* happineſs conſiſts in having our wants ſupplied; *his* in having no wants to be ſupplied. Hence this delightful truth, the creation of a world (ſince it could not add to his happineſs) is entirely owing to his goodneſs: or the happineſs of his creatures was his only view; and his deſigns cannot fail of attaining their end.——But, to conclude, how will you ſatisfy yourſelf in all time coming, that *God is*, and *is ſuch a being?* For it is one thing to ſee a truth, and another thing to retain an habitual knowledge of it afterward.

M. I will call to mind the ſeveral reaſons which force the mind to acknowledge a Deity, and the perfections of his nature.

P. I mean, how will you come at a ready view of this at any time, without entering into a long train of reaſoning?

M. I will look to the heavens, or to the earth. A glimpſe of the ſun or ſtars, any living creature, any vegetable being, will kindle up the whole train of thought in my mind. I will conſider my own body, or a part of it. There, though I do not ſee the Deity with my eyes, I cannot help perceiving his power working a thouſand ways. How can I loſe ſight of the Deity, when the conſiſtency and preſervation of all things, *above*, *below*, and *round* me, nay in the very body, ſhew him conſtantly ſupporting and directing that very particular, to which I point my thought.—— Though I abſtract from all material things, if I

call

call to mind any *immutable* and *neceſſary truth*; in that I ſhall perceive (if I durſt ſo expreſs myſelf) the *divine intellect*. In a word, ſince I cannot withdraw myſelf from his preſence, nor from amidſt the operations of his power; I muſt find God, *powerful* and *wiſe*, and *good*, in every thing I either look at or reflect upon.

P. Can any one doubt then, whether God *be*, becauſe he does not diſcover him with his eyes?

M. Such a man muſt doubt for no other reaſon, but becauſe he had no reaſon to doubt. If the Deity could be diſcerned with bodily eyes, which are deſigned for the perception of corporeal objects, he would not be that *neceſſarily exiſting*, *infinitely perfect being*, whoſe nature conſtitutes our happineſs. The ſoul itſelf, of the exiſtence of which we cannot doubt, ſince our very doubting proves the thing, is not thus to be perceived. He who doubts whether the Deity *be*, becauſe he does not ſee him, ought to demand a ſight of his own ſoul, in order to be ſatisfied that he is a living being. We ſee the whole frame of nature contrived by his wiſdom, and ſupported by his power: this is the fulleſt, the ſtrongeſt view, the heart of man can deſire!

P. You expreſs the thing well. The man knows not what he would have, who complains for want of this ſort of proof, for want of ocular demonſtration: we have it in the ſtrongeſt manner poſſible. For while we look at any thing which the eyes can perceive, we behold that very thing, which unleſs the Deity were, could not be. So impoſſible is it to ſee any thing, which doth not ſhew us the Creator of heaven and earth! We are *eye-witneſſes* every moment of the *operations* of his power, while his knowledge *guides*

the

the motions and productions of nature. He doth not only preſide over the main of affairs, and manages inferior things by a delegated power, as ſome inconſiſtently imagine: no, he informs the meaneſt *reptile*, by his wiſdom, to all the ends of its exiſtence; he conducts every herb, every plant of the field, to its ſpecific perfection; and directs all the motions in the heavens, and all the changes on the earth.

M. It would, in truth, be extremely fooliſh in us, after we were forced to allow that he binds together by his power the ſolid ſubſtance of matter, to deny that he conducts the inactivity of it, in all the changes it undergoes. It was thus you diſcovered to me the origin of motion. The various exertion of the ſame power, which binds together the ſolid ſubſtance, moves it.

P. They who would place the dignity of *almighty power*, and *infinite knowledge*, in eaſe and inactivity, ſeem to have their thoughts on ſome *eaſtern tyrant*, while they are ſpeaking of the Deity; and meaſure his happineſs by their own nature, and want of power.

XCI. And now, Matho, we have brought the ſubject of our conferences to a cloſe; having obſerved what was moſt neceſſary and obvious, concerning the material univerſe, the ſouls of brutes and men, and concerning the *adorable Deity* himſelf: I cannot be of any farther ſervice to you, nor can we leave off at a more proper place.

M. Nay, Philon, I beg you would not think of that ſo ſoon. There are ſtill ſome particulars concerning the *motions of the planets*, which I would fain underſtand in ſome degree; and in thoſe matters I can do nothing by myſelf. Beſides,

ſides, ſome things you know in our former diſcourſes you referred to a more proper place.

P. You do not conſider, Matho, that the longer we continue our conferences, the more things we muſt refer; in which, perhaps, I can give you no ſatisfaction at laſt.

M. Let us at leaſt converſe on thoſe ſubjects: for I have obſerved all along, that while you are ſpeaking on any thing, many thoughts offer to me, which would not have otherwiſe occurred.

P. This is generally the caſe, when two perſons converſe together with openneſs and friendſhip. By endeavouring to unfold our difficulties, we ſometimes diſcover the reaſons of things we were ignorant of: and in this view only can I pretend to talk on thoſe ſubjects with you for the future.——But I cannot help being ſurprized, that at an age when others amuſe themſelves with trifles, you ſhould ſo warmly purſue theſe ſeverer enquiries, in which you muſt certainly find no ſmall difficulty.

M. Shall I freely tell you, Philon, what I have hitherto obſerved in the courſe of my education?

P. With all my heart. I ſhall be pleaſed to hear your obſervations; they muſt be ſomewhat ſingular, and entertaining, I ſuppoſe.

M. The ſubjects we have touched upon, ſeem ſcarce to have any difficulty, in compariſon of thoſe things, which are forced upon us, almoſt when infants. What can be more hard and unintelligible to us, than to hear of the different *declenſions* of *nouns*; the *moods*, *tenſes*, and *conjugation* of *verbs*; with *genders*, *caſes*, and the reſt of that ſtuff? In the ſubjects we have hitherto ſpoke of, reaſon convinces and ſatisfies the mind, and truth rewards it with pleaſure: but in the firſt

beginnings of *language* and *grammar*, every thing is horrid, rough, and really terrible to a child. Inſtead of reaſon, we are told of *authority*, and the *rule of cuſtom*, which has often both approved and condemned the ſame forms of ſpeech, as new modes of expreſſion prevailed. I wiſh our *parents* and *maſters* would conſider how conſiſtent it is to be ſo ſevere with us when infants, and to ſpare us ſo much when more advanced. It looks as if they thought the art of ſpeaking, or rather, the knowledge of words, was preferable to the art of thinking. We are laſhed into the knowledge of a heap of words, and after that left to our own diſcretion, to think rationally, or otherwiſe, as we have a mind, or rather, as it happens.

P. But ſtill you muſt allow, Matho, that children may learn to ſpeak, before they can think to purpoſe.

M. Can they ſpeak to purpoſe, before they think to purpoſe? They may prate, before they can think to purpoſe. And why do they not learn to prate Latin by the ear, as they do Engliſh? They would acquire this in leſs time than they are now in preparing the way to it. I have heard good judges ſay, that a boy may learn more Latin in two years, in a place where it is conſtantly ſpoke, than in four, by the ſtiff formal method of rules, without that practice. From the reſtraint we are under leſt we ſhould talk falſe Latin, we never acquire that ready command of the language, which might be eaſily attained by ſpeaking it. Before we underſtand a plain familiar ſtile, we muſt be let into the beauties of poetical diction. Great pains are ſometimes taken to point out to us the lofty ſentences in our authors, when perhaps we ought not ſo much as to have

heard

heard of the things, which thoſe ſentences contain. Is not this ſhewing a very partial regard to ſound?

P. I own, if that be the caſe, the pains taken ſeem to be miſplaced.

M. Is it not the caſe? What boy is not taught with great pomp,

Ille pater, rectorque Deûm, cui dextra triſulcis
Ignibus armata eſt, qui nutu concutit orbem,
Induitur faciem tauri, miſtúſque juvencis
Mugit, &c.

Here is a notable contraſt, as I take it, between the abſurdity of the ſenſe, and the ſublimity of the expreſſion; nor are the paſſages of this ſort few in number.

P. I fancy, Matho, it would be agreeable enough to hear your criticiſms on the books you have read: pray which are your favourite authors?

M. I do not pretend to criticiſm, though I know what pleaſes myſelf. It appears to me, that the hiſtorians may be read with pleaſure and profit. I have read Cæſar, and ſome books of Livy, with ſatisfaction; and the leſſer authors that are put in our hands before theſe. The ſhort lives of Cornelius Nepos, ſeem to me well fitted for children: nor do I find ſo much fault with Juſtin's want of chronology, as is generally done. Boys rather mind the thread of the narration, than the diſtinction of years: let that be as it will, a little pains of the maſter would make that an uſeful book.

P. You ſay nothing of the poets.

M. I have but little to ſay of them: what does it concern me to know whether Alexis was Pollio

or Mecænas's boy? or who he was? I ſhould have been at no great loſs, though I had never heard of him.

P. I agree with you; we can reap no great profit from a thing, which we muſt be cautioned againſt, leſt it do us hurt.

M. That brings to my mind the *Silenus* of the ſame admired author; the ſafeſt way of explaining which to a young lad, I think, is to leave him ignorant of the ſenſe.

P. That is a new way of explaining things!

M. Conſider the ſtory of *Paſiphae*, which the poet dwells upon with nauſeous length, and ſeems to leave unwillingly, and tell me whether you are not of my opinion?

P. I am not ſo ready in theſe things as you.

M. And then I dare ſay the ſchool-boy who underſtands

——*uti magnum per inane coacta*
Semina terrarumque, animæque, mariſque fuiſſent——

will be in a fair way to underſtand as difficult things as any we have yet ſpoke of. I am ſure I plagued both my maſter and myſelf heartily about it, with no great ſatisfaction to either of us. And pray, Philon, is it not ſtrange, that while they think us capable of entering into theſe things, they ſhould think us incapable of the leaſt grain of truth, or rational principles?

P. But every thing is not ſo exceptionable, as the paſſages you have cited.

M. A notable recommendation, that every thing is not ſo abſurd! If every thing that is exceptionable were taken out (ſo far as I have read, or am capable to judge) there would be great *chaſms*, I am afraid, in the ancient poets.

P. How comes it then, Matho, that thoſe authors have been the admiration of the world for ſo many ages? and that the moſt perfect moderns are only ſo far tolerable, as they imitate thoſe ancient writers?

M. Let them have been the admiration of men as much, and as long as you pleaſe; you will hardly perſuade me, that boys ſhould be taught every part of them indifferently, or to underſtand many places that are commonly taught: and if I were a man, I think I could find other things to admire. Truth charms in any dreſs; take the ſhining paſſages you admire moſt, put them in other words, and all you admire is gone. The *ancients*, without doubt, underſtood the art of writing, and were well acquainted with the influence that ſound and cadence has on the affections of the heart and paſſions of men. But were it not worth while to caution young lads with reſpect to this art, that it is an edge-tool, and may be equally applied to a good or a bad purpoſe? and to point out the paſſages where the ancients have abuſed it? It is not a very eaſy thing to admire the expreſſion, and have a juſt contempt for the thought. Let a man firſt convince the underſtanding, and then raiſe the paſſions on that ſide, as much as he can: but to draw the affections to one ſide, when ſenſe and reaſon perſuade us on the other, is both hurtful and ridiculous. And I would aſk you one queſtion, Philon, whether the exceſſive veneration for thoſe compoſitions has not hindered things of greater moment from being applied to as they ought? or whether theſe are not the only books recommended to the admiration of young lads? Every one affects to find out new beauties in them, and to be

be a perſon of ſuperior taſte; as if every ſyllable contained a treaſure of myſtery.

P. You are growing warm, Matho; take time to cool a little.

M. I can think for myſelf in theſe matters, without envying other people their admiration of ſound, or troubling them with my notions: but you deſired me to ſpeak my mind freely. However, I ſhall have done, after obſerving that it ſeems to me, from my own experience, a wrong method to confine us to the ſtudy of words ſo many years; poſtponing the conſideration of things, and thoſe abſolutely neceſſary, to the laſt day of our lives perhaps: for unleſs our minds are early tinctured with the firſt principles of true philoſophy, together with the knowledge of letters (which I conceive may be done by way of recreation, and diverſifying our other buſineſs) it is poſſible that the greateſt part of us may never have another opportunity to hear of theſe things; or none, at leaſt, ſo fit: ſince we dwell on language ſo long, and commence men ſo ſoon.

P. Some of your obſervations, Matho, are not amiſs; but all that concerns private perſons, is to purſue the method they think moſt rational.——You have fatigued me as much, as you did your maſter, on the explication of the Epicurean formation of the world: I muſt therefore beg a reſpite.

M. I willingly agree to it.

The END *of the* FIRST VOLUME.

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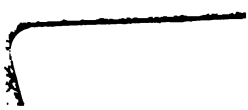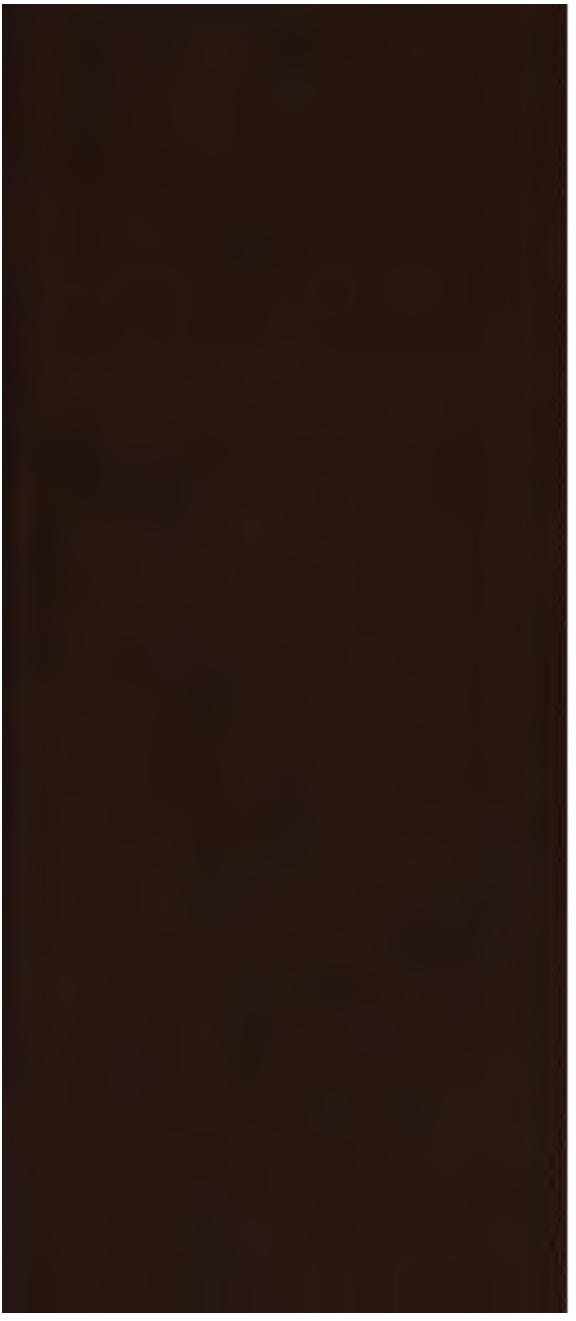
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